Characterization of farming systems in Africa RISING SIMLEZA intervention sites in Zambia

Mirja Michalscheck, Carl Timler, Katrien Descheemaeker, Jeroen Groot

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Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. http://africa-rising.net/

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List of abbreviations

Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
BNF	Biological Nitrogen Fixation
DC	Detailed Characterization (Survey, performed by a WUR team in June 2014)
CIMMYT	International Maize and Wheat Improvement Center
FSE	Farming Systems Ecology (Group – Wageningen University. Netherlands)
IITA	International Institute for Tropical Agriculture
NSRL	National Soybean Research Laboratory (United States of America)
ODK	Open Data Kit (Software for Data Collection on Android handheld devices)
PCA	Principle Component Analysis
PPS	Plant Production Systems (Group – Wageningen University, Netherlands)
RO	Research Objective
SI	Sustainable Intensification
SIMLEZA	Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia
TLU	Tropical Livestock Unit
USAID	United States Agency for International Development
WUR	Wageningen University and Research Centre, Netherlands
ZMK	Zambian Kwacha 1 000 ZMK = 1 ZMW (out of use since June, 2013)
ZMW	Zambian Kwacha (in use since January, 2013)

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Annex 1 – Baseline Survey Household Questionnaire for Eastern Zambia – 2011/2012

Annex 2 – Survey tool for detailed farm characterization – June 2014

Annex 3 – MSc thesis report Karoline Hemminger (July 2014): Towards integrated assessment of gender relations in farming systems analysis. Farming Systems Ecology group and Rural Sociology group, Wageningen University, The Netherlands.

The appendices can be found as separate files provided as supplements to the report.

Acknowledgements

This report is the result of an intensive interdisciplinary research effort on local farming systems in the joint intervention sites of the AR-SIMLEZA project in the Eastern Province in Zambia.

The assignment was commissioned by the International Institute for Tropical Agriculture (IITA) within the Africa RISING project funded by the Feed The Future initiative of the United States Agency for International Development (USAID). We thank our commissioner Irmgard Hoeschle-Zeledon of IITA, and the support of Jerry Glover and Tracy Powell of USAID.

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For the surveys in June 2014 we could count on the amazing support of several translators, namely: Emma Chipandwe Phiri, Theresa Bwalya, Jucilia Hachamba, Betty Mwula, Bismark Munankombwe (Camp Officer in Hoya, Lundazi) and John Njobvu (Camp Officer in Vuu, Lundazi). We would particularly like to thank Mulundu Mwila and Abell Mwale (IITA) for their great support during our field work and with the data collection for the detailed characterization of local farming systems.

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samples in the FSE laboratory at Wageningen. Christian Thierfelder and Walter Mupangwa shared the agricultural field trial results from the research station Msekera in Chipata with us. This information was essential in informing our model assumptions in Farm DESIGN and hence we are highly grateful for that. Moreover, we discussed the choice of possible entry points to be modelled with Christian, Walter and Mulundu. Altogether, there was a good level of exchange between the project staff at all levels and we are very grateful for all the contributions that enabled us to better fulfill our part as Wageningen University to the AR SIMLEZA project.

Last but not least we would like to thank the very welcoming, patient and outstandingly open farmers we visited for the detailed farm characterization. Without their support and the great amount of information we would not have been able to do the in depth farming systems analysis as presented in this report. These farmers were selected as being representative for an entire group of farmers, all belonging to the same farm type. Hence their information was of greater importance than just their individual case study.

This report therefore is the result of a joint effort of all of the above-mentioned participants and we are highly grateful to all of the contributors!

Executive summary

This report presents the findings of a first cycle of farming systems analysis within the project-alliance between SIMLEZA (Sustainable Intensification of maize-legume Systems in Eastern Province of Zambia) and Africa RISING (Africa Research in Sustainable Intensification for the Next Generation). Africa RISING is a research program of the Feed-the-Future initiative of the USA government. The Department of Plant Sciences of Wageningen University and Research Centre (The Netherlands) performed this analysis in the period March to September 2014.

The objective of the first cycle of farming systems analysis within the AR-SIMLEZA project was to characterize farming systems in project intervention areas in Eastern Zambia, to make farm typologies, and to find constraints and entry points for sustainable intensification and innovation at the farm level. The applied methodology comprised five steps:

1. Formulation of a farm typology on the basis of an existing baseline survey.
2. Detailed diagnosis of a representative subset of farms selected from the typology through farmer interviews.
3. Evaluation of entry-points for sustainable intensification that were proposed within the AR-SIMLEZA program.
4. Model-based exploration of trade-offs and synergies among various environmental and socio-economic performance indicators of farms, as reflected in a set of alternative farm configurations for representative farms per type, and
5. Selection of desirable farm configurations from the perspective of farmer objectives and motivations, for further fine-tuning and redesigning the case study farms.

Social wellbeing and economic development in Zambia are however strongly dependent on a productivity growth and a sustainable management of resources in these agricultural systems. Therefore, there seems to be a great need for sustainable intensification of local farming systems, for instance through promoting best practices in maize-legume integration. Legumes (e.g. soybean, cowpeas, beans and groundnuts) not only provide a great source of proteins to humans, they also provide nutritious residues as feed to livestock as well as add nitrogen to the soil. A farming systems-approach adopted in this project allows assessing the combined and various effects of changes in the farm design on all other systems components, and thereby the ex-ante evaluation of promising entry-points for sustainable intensification. Potential entry-points identified within the AR-SIMLEZA include crop management practices such as:

- Maize-legume intercropping;

- Maize-legume rotation;
- Residue retention

The analysis was conducted at the AR-SIMLEZA joint interventions sites in the Eastern Province encompassed the camps of:

- Kapara, Chiparamba (Mtaya) and Chanje located in the Chipata district.
- Kawalala and Kafumbwe located in the Katete district.
- Hoya and Vuu located in Lundazi.

Smallholder farmers in the Eastern Province manage on average 5 ha of land, of which 3.5 ha are cultivated. They plant on average 3-4 different crops; the main crops are maize, groundnuts and sunflowers. Farmers also grow sweet potatoes, soybeans, cotton, pumpkins, tomatoes, beans, cowpeas, bananas, cabbage, cassava, rape, sugarcane and tobacco. On average 22% of the farm area is cultivated with legumes such as common beans, soybeans, pigeon peas, groundnuts or cowpeas.

Five farm types were identified from the baseline survey data set using the following key variables:

- Operated area (ha) [1]
- Tropical Livestock Units (TLUs) [1]
- Total labor inputs (person days per year) [1]
- Proportion of total labor input used for land preparation [1]
- Proportion of total labor input used for weeding [1]
- Off farm income (Zambian Kwacha, former currency) [1]
- Crop income (Zambian Kwacha, former currency) [1]
- Cost for hiring labor (Zambian Kwacha, former currency) [1]
- Legume Ratio (proportion of total operated area cultivated with legumes[2]) [1]
- Years of experience in growing legumes [1]
- Legume Score [3] (Average score given to all legume varieties)

The identified farm types could be characterized as follows.

- Type 1: low resource endowed, most labor for land preparation, legume growers, most food insecure.
- Type 2: low resource endowed, most labor for weeding, few legumes grown.
- Type 3: medium resource endowed, legume growers, highest relative animal income.

[1] The values of these variables were transformed through normalization

[2] Legumes included common bean, soybean, pigeon pea, groundnut and cowpea

[3] Scores: 1: Very poor, 2: Poor, 3: Average, 4: Good, 5: Very good

- Type 4: medium to high resource endowed, highest off –farm income.
- Type 5: high resource endowed, high crop and animal income.

Per farm type, three farms were selected for detailed characterization on the basis of an interview during farm visits. The constraints were different between the farm types, with particularly labor constraints in the smaller farms, to limited possibilities for expansion of farm area and deficient infrastructure in the larger and more resource endowed systems. Farmers from all types experienced problems with low soil fertility, limited input availability and high costs of inputs, and insufficient information and knowledge on farming practices and innovations. Similarly, the objectives and motivations of farmers differed between the farm types, from a focus on higher production per area and achieving food security in the lower resource endowed types towards farm expansion, status and material ambitions in the higher resources endowed farm types.

A model-based analysis was made of various options to leave crop residue as mulch on the field and to integrate legume crops. In general, these changes resulted in more labor requirement and reduction of the profitability of farming despite the additional sales of the introduced legume crops, but an increase of the soil organic matter status and the nitrogen inputs through symbiotic fixation. The intensity of these changes differed between farm types.

The effects of legume integration as relay-crop or intercrop were further investigated in explorations of trade-offs and synergies. Changes in the farm configuration of the five farm types were tested to assess impacts on operating profit (objective to maximize), labor requirements (objective to minimize) and organic matter inputs into the soil (maximize). Potential options for change in cropping systems were: maize cowpea intercrop, sole soybean crop, sole cowpea crop, maize after cowpea and maize after soybean.

Tradeoffs were identified between increasing operating profit and the other two objectives (increasing organic matter inputs and reducing labor required) for the five farm types, with only a few exceptions. In general, increasing the operating profit would require an increase in labor input, and farm configurations with larger amounts organic matter inputs into the soil would have lower operating profit. There was a synergy between increasing organic matter inputs and reducing the labor requirements. Dependent on the objectives per farm type different adjustments in the cropping system would be most appropriate for the various farm types. Sole legume crops like soybeans were found beneficial to type-1, -4 and -5 farmers, whereas type-2 and -3 benefitted more from sole cowpea. For types -2, -3 and -4, including maize after the legume crop was found to be beneficial. Only the type-4 farm was shown to have some benefit from an intercrop of maize and cowpea. The next step is to return to the farmers to discuss these suggestions and to gain their viewpoint in how such an exploration can aid them in (re-) designing their cropping systems to achieve their objectives.

1. Background and objectives

In Zambia maize is the main staple food crop and, with a share of 55% in the daily calorie intake of the local population, it is critical for ensuing the national food security. Of the total maize consumed in Zambia, smallholder farmers produce 80% in rain-fed systems under low soil fertility, frequent drought, and with a limited use of high yielding varieties or inorganic fertilizer.

Social wellbeing and economic development in Zambia are however strongly dependent on a productivity growth and a sustainable management of resources in these agricultural systems.

There seems to be a great need for sustainable intensification of local farming systems, for instance through promoting best practices in maize-legume integration. Legumes (e.g. soybean, cowpeas, beans and groundnuts) not only provide a great source of proteins to humans, they also provide nutritious residues as feed to livestock as well as add nitrogen to the soil.

The Africa RISING SIMLEZA (AR-SIMLEZA) project focuses on eastern Zambia where small-scale farmers depend for their livelihoods on maize-legume mixed systems characterized by low productivity, extreme poverty, poor soil fertility and environmental degradation. The project aims at leveraging science for sustainable productivity growth, intensification and diversification of maize based systems in the region through new varieties, improved agronomic practices, legume integration, and improved access to markets and services.

This report focuses on farming systems analysis and options for sustainable intensification of smallholder systems in the AR SIMLEZA joint intervention sites.

The rationale (section 1.1) explains the contributions of this research approach and findings to the AR-SIMLEZA project as well as to agricultural research in the region. Section 1.2 provides further details about the AR-SIMLEZA project itself and section 1.3 presents the specific objectives that underlie this project phase and hence also this report. Section 1.4 provides a definition of the two key concepts that fundamentally shaped this research: ‘farming systems analysis’ and ‘sustainable intensification’.

1.1 Rationale

The focus on sustainable intensification in the exploration of farm type specific redesign options for local farming systems was applied in this research since it has proven a powerful option to shape agricultural support to be more targeted, effective and sustainable.

The farming systems analysis presented in this report was based on farm surveys, characterizations and discussions with farmers. This allowed model-supported diagnosis and exploration of whole-farm options for sustainable intensification. A systems-level approach allowed embedding proposed and tested innovations for individual crops, products and other resources such as manures. In the exploration phase large sets of alternative farm configurations were generated on the basis of the current farm organization and suggested entry points and associated technologies and practices. It is hypothesized that the presentation and discussion of sets of options is beneficial to:

- Show trade-offs and synergies among farm performance indicators, thereby clarifying to farmers the room to maneuver.
- Offer diversity and choice in stakeholder discussions to facilitate adoption processes.
- Avoid lock-in onto undesirable development paths.
- This is expected to inform interactive adaptation and learning cycles conducted with farmers and other stakeholders.

Despite the primary function of this research to improve the agricultural support by AR-SIMLEZA, this report provides new insights into farming systems in the region, into the local farming systems diversity and farm type specific opportunities and constraints.

1.2 Project

This report is a result of a joint research effort of SIMLEZA Africa RISING (AR-SIMLEZA), a strategic alliance between the SIMLEZA (Sustainable Intensification of maize-legume Systems in Eastern Province of Zambia) and Africa RISING (Africa Research in Sustainable Intensification for the Next Generation - www.africa-rising.net) projects.

Both projects aim to create opportunities for smallholder farm households to escape hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. While SIMLEZA is focused on improvements in productivity, market access and resilience of selected maize-legume systems in the Eastern Province of Zambia, Africa RISING has worked with communities in Ghana and Mali (West Africa) as well as in Ethiopia, Tanzania and Malawi (East and Southern Africa). In the scope of the Africa RISING project the Department of Plant Sciences of the University of Wageningen (WUR) has already performed a farm typology, a farming systems analysis and an exploration of different entry points for sustainable intensification in Ghana, Mali, Tanzania and Malawi.

The task of Wageningen University in the scope of the AR-SIMLEZA project concerned work package 1 and hereunder specifically activity 1.5: Farming systems and site characterization in joint intervention sites in eastern Zambia to improve targeting of interventions. The research performed for the Zambian intervention sites could therefore considerably benefit from the prior experience in farming system analysis and lessons learned in the other AR intervention sites.

The joint research in Zambia was built on the existing SIMLEZA project activities and prior research outputs such as trial results, a baseline survey from 2011 as well as an adoption survey assessing the reasons for adoption and non–adoption of farming practices suggested by SIMLEZA. The Africa RISING project complements the existing research by an in-depth analysis of local farming systems, by suggesting a farm typology for improved targeting of interventions and by exploring trade-offs associated to the suggested farm-level changes using the Farm DESIGN model.

1.3 Objectives

The objectives for the AR-SIMLEZA farming systems analysis were to find constraints and entry points for sustainable intensification and innovation at the farm level. Subsidiary objectives were:

- To characterize the diversity of farming systems within the action sites.
- To diagnose the systems in terms of productive, environmental and economic farm performance.
- To explore trade-offs and synergies among various farm performance indicators.
- To identify potential points of improvement based on farm interviews and model explorations.

1.4 Key concepts

1.4.1. Farming Systems Analysis

For the purpose of this research a farming system shall be defined as an embedded ‘unit of (agricultural) production’ (Norman and Gilbert, 1981) – embedded in a certain ecological

landscape, an economic system with local and regional markets and a social system with traditional procedures and relations. Generally, the analysis of a farming system comprises five elements, namely: the system boundary, the inputs, the outputs, the subsystems and the internal structure (Giller, 2013). For modelling purposes, we draw the system boundaries around physical farm components such as the fields, the buildings, the animals, the crops as well as farm related machinery. Associated inputs such as labor, seeds, fertilizers, pesticides or organic matter imports (e.g., fodder, firewood, mulch or manure) as well as associated outputs, such as grain yields and animal products, are naturally linked to the farm components. The cropping and the livestock subsystems are usually integrated and strongly interrelated, e.g. through feed production and provision of manure. All management aspects related to the farming system are functional components and strongly determine the internal structure of the farming system.

For the research at hand we performed a farming systems analysis, which entailed that a selected farming system was captured with all its components and reviewed according to its current economic, social and ecological performance. Being interested in the sustainable intensification of this farming system, we were looking for changes that promised improvement in all three dimensions (economic, social and ecological objectives). AR-SIMLEZA has identified crop management practices such as maize-legume intercropping and maize-legume rotation as well as residue retention as promising options and hence the effects of these changes on the farm performance were explored (for results see section 5 and 6). Revealing the impacts of these changes on all farm components provided an impression of their suitability for the specific farm (and ideally also for the farm type they were to represent). The exploration of alternative farm configurations was then the last step in the computer-aided farming systems analysis.

The systems-approach allows assessing the combined and various effects of changes in the farm design on all other systems components. For instance adding a new crop to a farm will affect the labor requirements, the type and amounts of yields (as well as the household nutrition and sales) and the availability of animal feeds. The whole farm model will display these changes and provide an excellent basis for discussion.

1.4.2. Sustainable Intensification

Sustainable intensification of farming systems can be defined as changes in their resource use and allocation that increase farm productivity while reducing pressure on local ecosystems and safeguarding social relations. According to Pretty *et al.* (2011) this entails the efficient use of all inputs to produce more outputs while reducing damage to the environment and building a resilient natural capital from which environmental services can be obtained. Sustainable intensification results from the application of technological and socio-economic approaches that

may be categorized into genetic, ecological and socio-economic intensification (The Montpellier Panel, 2013).

Genetic intensification makes use of improved livestock breeds and/or crop varieties with greater yielding capacity, nutrient use efficiency, nutritional value and / or resilience to pests and diseases than material currently available to farmers.

Farm management practices such as intercropping are viewed as a means for **ecological intensification** because, for instance, intercropping improved maize (*Zea mays* L.) hybrids with legumes such as pigeon pea (*Cajanus cajan* (L.) Millsphaugh) may lead to increased land-use efficiency, crop diversity, soil fertility and farm household income if competition between component crops is minimized while beneficial interactions are maximized. The use of crop residues for livestock feed and farmyard manure for ameliorating soil fertility or use of natural enemies to control pests highlight the potential advantages of increased biodiversity at both farm and landscape scales.

Means for **socio-economic intensification** are measures that reduce labor requirements as well as the need for costly external inputs such as fertilizers and pesticides.

Having defined the envisioned direction of change (towards sustainable intensification as described above) it is important to measure the progress of a farming system towards it. Concretely, we must then ask: What changes contribute to what extent to achieving the sustainable intensification of a particular farming system? What are meaningful indicators to evaluate the proposed changes?

During various Africa RISING project meetings (SI workshop in Ghana, July 2013; Learning Event in Ethiopia, September 2013) participants generated a matrix encompassing 5 domains, with measurable indicators for sustainable intensification (see Figure 1.1). Section 2 explains how our farming systems analysis covered these measurable dimensions of sustainable intensification.

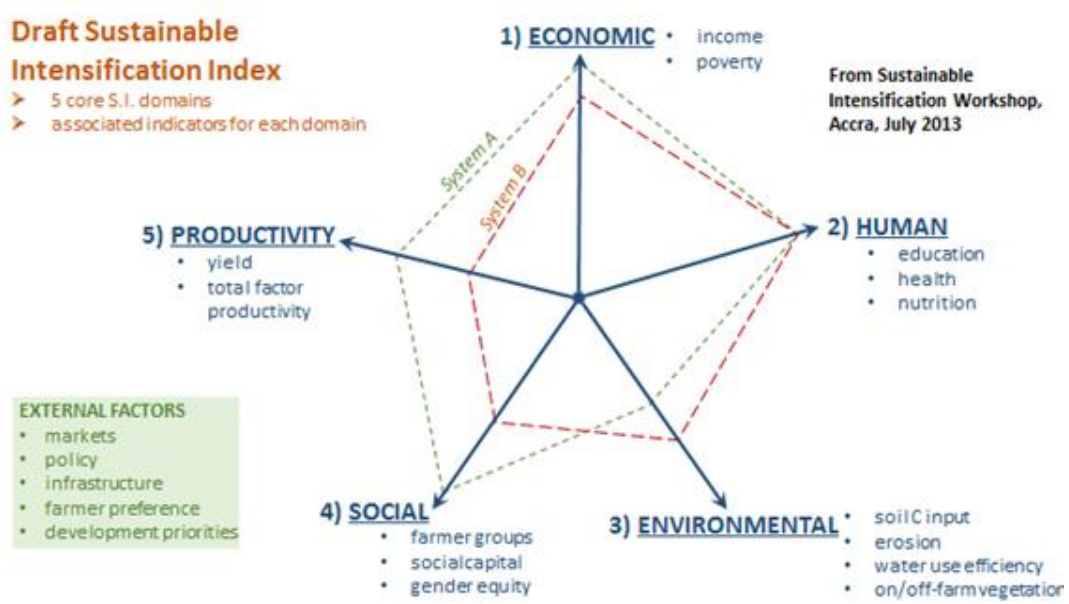

Figure 1.1. Example spider diagram illustrating a 5-dimensional indicator system for sustainability assessment.

2. Methodology

2.1 Conceptual approach

The farming systems analysis worked around the following framework, with specific activities highlighted in the grey boxes (Figure 2.1). In summary, the process started with a rapid farming system characterization exercise that allowed the development of functional farm typologies. For the rapid characterization the SIMLEZA baseline survey of 2011 was used to obtain a first impression of local farming systems, of their diversity and to derive a statistical farm typology. Grouping farmers into farm types allowed choosing the most representative farmers per type for a detailed characterization survey, which was conducted during a field visit in June 2014. The detailed farm characterization constituted the ground for a complete farming system diagnosis and an exploration of innovations in the whole farm model Farm DESIGN. The exploration then yielded suggestions for system redesign, aiming at an improvement in the economic, social and/or environmental performance of the current farming system.

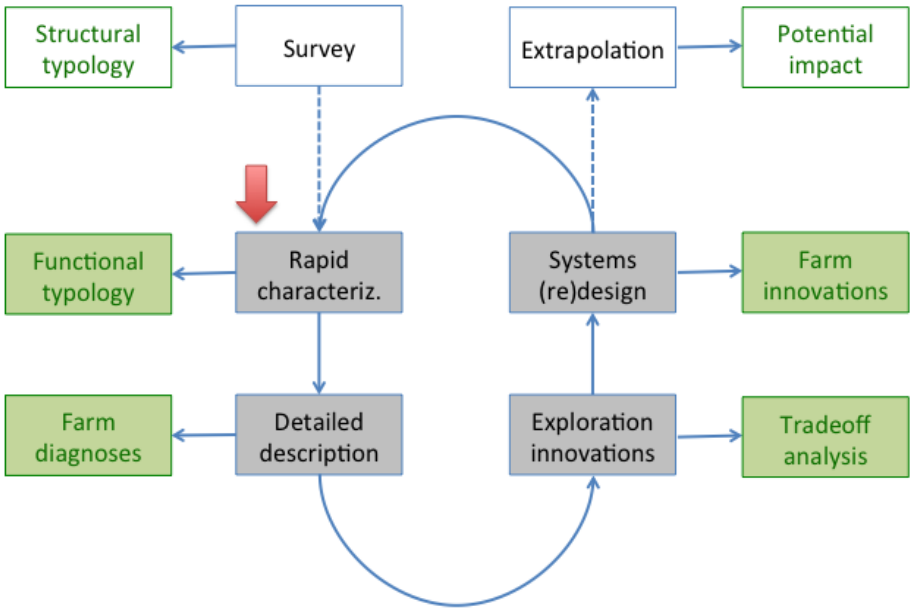

Figure 2.1. Components of the farming system analysis and entry point identification strategy. Research phases in the analysis represented by grey boxes, products indicated in green boxes. Starting point of the analysis indicated with the red arrow. Activities in white boxes fall outside the scope of this work.

Since the farming systems analysis constituted the core of this research, the associated single steps and concepts shall briefly be elaborated here:

The data of the detailed characterization (DC) surveys formed the basis for the farming systems analysis. The DC surveys were conducted at the AR-SIMLEZA joint interventions sites, which are illustrated in the map in Figure 3.3 and encompass the camps of:

- Kapara, Chiparamba (Mtaya) and Chanje located in the Chipata district
- Kawalala and Kafumbwe located in the Katete district
- Hoya and Vuu located in Lundazi.

As mentioned in section 1.4.1, the farming systems analysis entailed that the selected farming systems were captured with all their components and reviewed according to their current economic, social and ecological performance. Being interested in the sustainable intensification of these farming systems, we were looking for changes that promised improvement in economic, social and ecological terms. The Farm DESIGN model can for instance be fed with changes targeted to boost the genetic, ecological and/or socio-economic intensification of the current farming system. The economic performance is usually linked to the farm productivity (crop and livestock yields and consequently their sales), altogether covering four of the five indicator-dimensions for sustainable intensification as presented in section 1.4.2. Gender and nutritional aspects are currently not built into the Farm DESIGN model and form part of the contextual discussion around the suggested changes.

The systems-approach allows assessing the combined effects of changes in farm configuration on all other system components. For instance adding a new crop to a farm will affect the labor requirements, the type and amount of yields (as well as the household nutrition and sales), organic matter dynamics, nutrient cycles and the availability of animal feeds. The whole farm model will display these changes and provide a basis for discussion. AR-SIMLEZA has identified crop management practices such as:

- Maize-legume intercropping;
- Maize-legume rotation;
- Residue retention

as promising options and hence the effects of these changes on the farm performance were assessed. Revealing the impacts of these changes on all farm components provided an impression of their suitability for the specific farm (and ideally also for the farm type they were to represent). The farming systems analysis including an impact assessment of specific entry points and an exploration of alternative farm configuration was for performed for five farms: One per farm type, which were found to be particularly representative.

While the farm types and their characteristics are presented in Chapter 4, the farm type specific options for system redesign are discussed in Chapter 5 of this report.

2.2 Survey tools

In 2011, SIMLEZA performed a baseline survey, capturing information on cultivated crops, livestock, land holdings, household assets as well as on their experience with legumes and different crop varieties. Beyond the farm level the survey also captured information on the farmers off-farm income, the farmers' access to markets and inputs, to institutional support as well as on health related indicators (see Annex 1 for the template of the SIMLEZA baseline survey). The survey captured 811 smallholder farm households in the three districts of Chipata, Katete and Lundazi in the Eastern Province of Zambia (see map in Figure 2.2). The baseline data was used to obtain a general impression of farm features in the region and as a next step to group these into farm types (see Section 2.3 for the methodology underlying the farm typology).

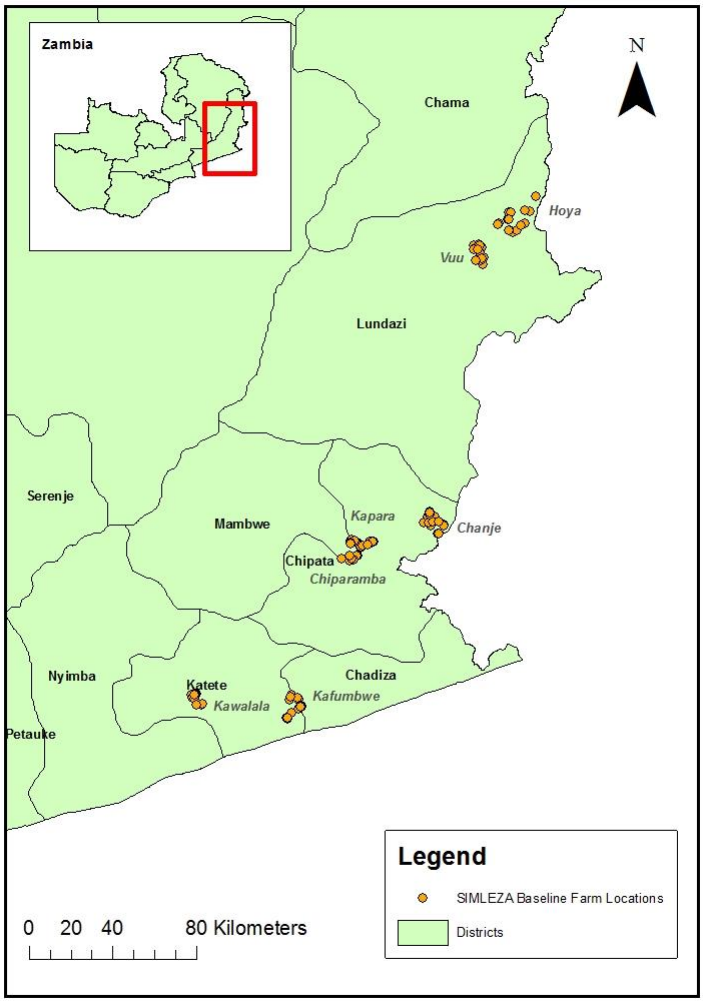

Figure 2.2. Locations of the AR-SIMLEZA Intervention Sites.

Five farm types were identified from the baseline survey data set. From the resulting groups of farmers we chose one representative case for each farm type in each district (particularly from the intervention sites within these as listed in Section 2.1) for a revisit and a detailed characterization survey in June 2014. The idea was to capture each farm type thrice (one example in each of the three districts). We hypothesized that the farms could have developed into a different direction (and thus belong to a different farm type) since 2011. The small sample of detailed surveys would allow us to again choose the most representative and information-wise most sound farm for the in depth farming systems analysis and exploration. Due to time and logistical constraints we only achieved to conduct fourteen instead of fifteen detailed farm surveys: a type 1 farm in Lundazi is missing, this does however not seem like a drawback for this research since the other two type 1 farms captured were suitable choices for the envisioned further analysis. The location and type of the farms visited in the scope of the detailed characterization are illustrated in Figure 2.3.

The detailed farm characterization survey tool was developed and used in 2013 for AR work in Tanzania and Malawi. The questions are tailored to the data needs of the Farm DESIGN model and capture information on crops, livestock, crop management and herding practices, sales of farm produce, detailed labor inputs, organic matter imports to the farm, manure storage and use as well as farm assets. The detailed characterization partly repeated questions of the baseline survey, which provided valuable indicators on changes in the farming system, at the same time putting the required additional information into the actual context. The survey tool of 2013 was extended with questions on the farmers' main challenges, his incentives and disincentives for (AR-SIMLEZA) specific changes in the farming system. Furthermore the farmers were asked what changes they envision in their farming systems, so that the suggestions of AR-SIMLEZA could be embedded into their preferences and perceptions. The survey tool for the detailed characterization can be found in Annex 2 of this report. The survey was also used on an Android tablet with the Open Data Kit (ODK) software, with the initial thought of facilitating later data entry into the model and data processing. The paper version of the survey however proved to be more flexible and suitable for the complex assessment of the farming system and hence we mainly continued to use the traditional paper based format of the survey. The data captured was entered directly into the Farm DESIGN model from where it could be analyzed.

In addition to the Farm DESIGN specific information, one of the WUR researchers accompanied the team to capture gender-related details of the farming systems. While the (typically male) household head was interviewed, a separate and simultaneous survey was conducted with the female household members to assess their views and knowledge of the farming system. If the wife was not available, we typically took the opportunity to ask neighbor women to describe their roles and gender-related differences in farming practices in their village. These interviews provided important additional insights into possible gender related opportunities and constraints to certain entry points (Hemminger, 2014).

In addition to the impressions captured on paper, we also took numerous pictures of the farm and the surroundings as well as a soil sample from each farmer's most productive field.

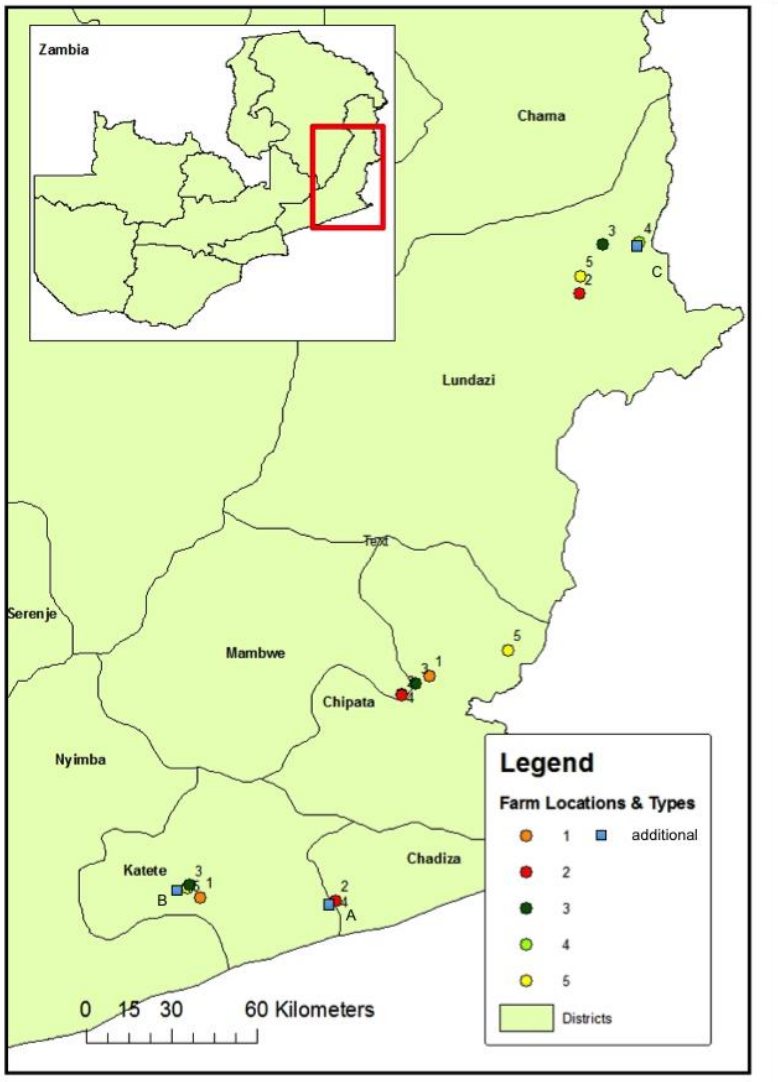

Figure 2.3. Locations of farms captured in the Detailed Characterization Survey in June 2014. The different colors indicate the different farm types covered.

2.3 Farm Typology

Smallholder farming systems are often highly diverse in terms of biophysical and socio-economic characteristics. The diversity among systems stems i.a. from differences in soil fertility, farmers' livelihood aspirations and resource endowment (factors for productivity) including land, labor availability as well as cash income. Hence, instead of providing 'blanket' recommendations for smallholder farmers in certain areas, recognizing and responding to the variability in local farm characteristics promises more appropriate, targeted and efficient design recommendations to achieve improvements in agricultural production (Ojiem *et al.*, 2006; Tittonell *et al.*, 2009). Farm typologies aim at meaningful groupings of farms into subsets, homogenous according to specific criteria (Anderson *et al.*, 2007; Van de Brand, 2011), which can be used for technology targeting. Creating these typologies attempts a meaningful compromise between analyzing every single farm and assuming broad categories such as smallholders in general.

Figure 2.4 illustrates the general procedure followed to produce the statistical farm types for the AR-SIMLEZA intervention sites. The farm types for this research were generated in the statistical program 'R' (http://www.r-project.org/- software package ade4).

The research objective was the definition and description of farm types that would facilitate targeting of agricultural support by AR-SIMLEZA. The baseline survey and an early expert consultation in May 2014 served to develop a hypothesis on important farm characteristics to discriminate between farm types. By means of stepwise elimination during the principle component analysis (PCA) the list of variables determining the different farm types was reduced to the following key variables:

- Operated area (ha) [4]
- Tropical Livestock Units (TLUs) [1]
- Total labor inputs (person days per year) [1]
- Proportion of total labor input used for land preparation [1]
- Proportion of total labor input used for weeding [1]
- Off farm income (Zambian Kwacha, former currency) [1]
- Crop income (Zambian Kwacha, former currency) [1]
- Cost for hiring labor (Zambian Kwacha, former currency) [1]
- Legume Ratio (proportion of total operated area cultivated with legumes[5]) [1]
- Years of experience in growing legumes [1]
- Legume Score [6] (Average score given to all legume varieties)

[4] The values of these variables were transformed through normalization

[5] Legumes included common bean, soybean, pigeon pea, groundnut and cowpea

[6] Scores: 1: Very poor, 2: Poor, 3: Average, 4: Good, 5: Very good

The PCA was followed by a hierarchical cluster analysis including 746 of the 811 farms from the SIMLEZA baseline survey resulting into 5 different farm types.

The farm types and their characteristics are presented in section 4 and were subsequently used to structure section 5 (farm type specific entry points).

For further information in typology development, please consult the typology guideline of Alvarez *et al*. 2014.

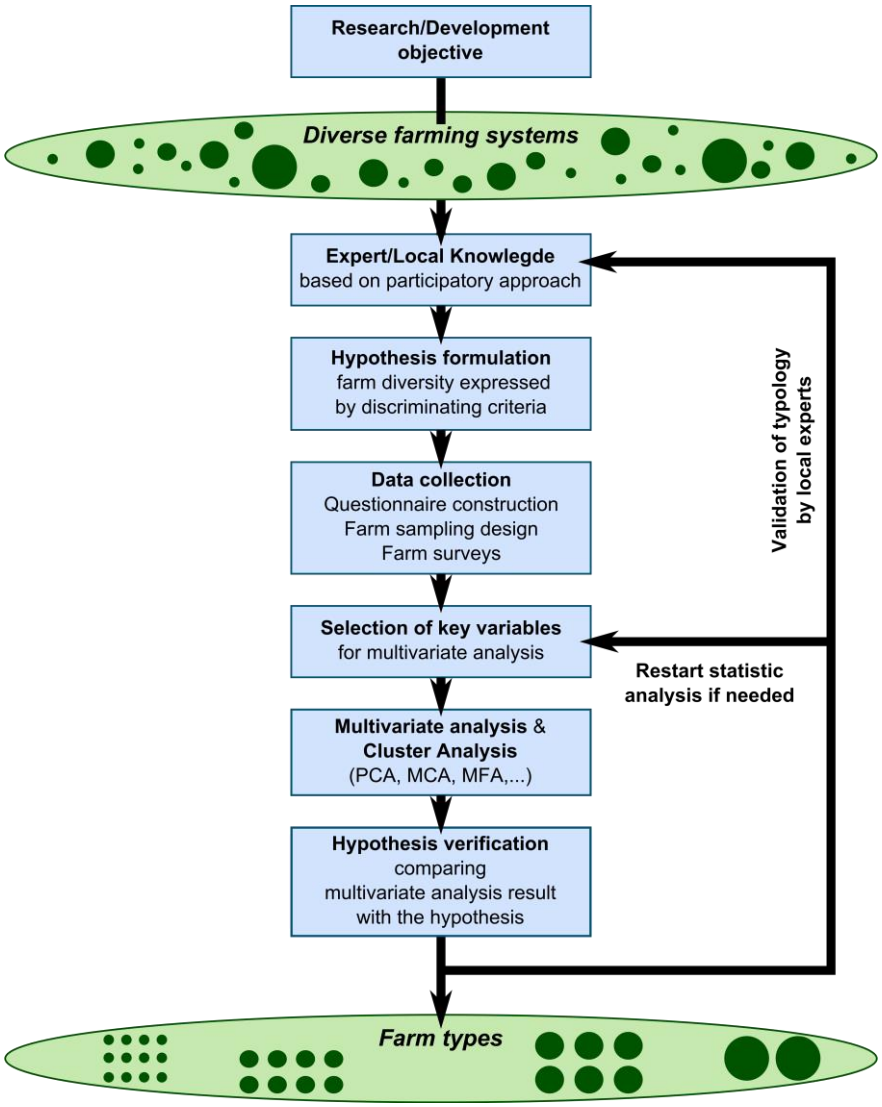

Figure 2.4. General framework of the typology process (PCA: Principal components analysis; MCA: Multiple correspondence analysis; MFA: Multiple Factorial Analysis). Alvarez *et al*. 2014

2.4 Modeling tool: Farm DESIGN

The Farm DESIGN tool is a bio-economic static model, capturing structural as well as functional farm characteristics (Groot *et al*., 2012). Farm DESIGN (the current version 4.1.3) captures information on the fields of the farming system such as plot sizes, crop types, intercrops and crop products, but also information on soil and climate characteristics. The model also records information on animals kept: types, numbers and products; as well as on crop-livestock management practices such as animal feed, crop fertilizer and pesticide use. Farm DESIGN further assesses the destination of crop and animal products such as the incorporation of residues into the fields or the monetary revenues from sales. The Farm DESIGN model hence captures biophysical and economic features as well as management aspects of the particular farming system. Figure 2.5 provides a schematic representation of the Farm DESIGN model.

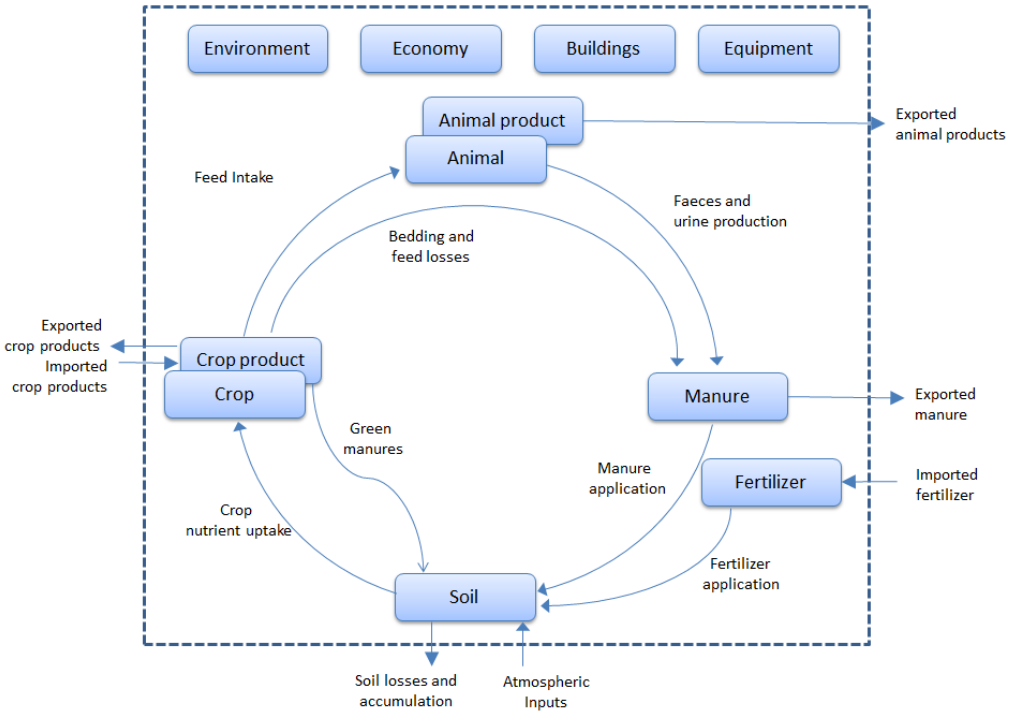

Figure 2.5. Schematic representation of the farm model and data within Farm DESIGN. The boxes indicate represent material flows quantified by the model. The dashed lines denote the farming system boundary with the external environment (Groot *et al*. 2012).

Concerning model inputs, Farm DESIGN refers to a one year period and hence requires cumulative annual figures e.g. yields obtained within a year or crop specific annual labor inputs. The model inputs were mainly obtained from the detailed characterization survey conducted in June 2014. The information was complemented by results of SIMLEZA trials at Msekera, by project reports as well as a substantial amount of external literature on crop characteristics,

animal features as well as descriptions of the local ecosystem, of socio-economic features and other contextual accounts.

Based on the mentioned inputs, Farm DESIGN determines annual feed, organic matter, operating profit and labor balances as well as detailed nutrient cycles (farm diagnoses). Beyond displaying the current farm features, Farm DESIGN allows to explore the impact of different management decisions as well as shifts in inputs and production priorities. By capturing the links between the different farm components, identifying ranges of possible variables for the single factors, setting constraints as well as desired outcomes, the interplay of farm components can be illustrated and manipulated, in order to explore and evaluate options for the (re-) design of the whole farming system.

Based on available resources, the model is given a delimited room to reallocate these aiming towards likewise defined farm objectives (desired outputs). The multi-objective optimization algorithms generate sets of alternative farm configurations that represent part of the window of opportunities or solution space for the case study farm. Farm objectives towards sustainable intensification may include a maximization of operating profits, a minimization of labor inputs and an augmentation of the soil organic matter balance. Residue allocation, purchase of certain animal types and sales of others as well as improved manure management may serve as decision variables to determine alternative farm configurations, while other parameters, such as a minimal amount of maize grain required for household consumption, may function as constraints, limiting the room of the model to maneuver. The optimization algorithm of Farm DESIGN is run at 1000 iterations, generating the same amount of alternatives for the explored farming system. The frontier of the resulting graphical solution cloud represents the possible Pareto-optimal farming systems alternatives according to the model.

The alternatives in terms of cropping and livestock activities are then evaluated in terms of tradeoffs and synergies among farm objectives. The information derived from the modeling exercise may be important in guiding discussions between farmers and other stakeholders towards the selection of a farm set-up that is likely to be adopted by farmers in a target area.

For more information on the Farm DESIGN model consult Groot *et al.* (2012), or visit https://sites.google.com/site/farmdesignmodel/home .

3. Introduction to the country and the case study regions

In the Republic of Zambia, agriculture supports the livelihood of about 70% of the 13 million inhabitants. Smallholder farmers produce 80% of the country's main staple crop maize in rain-fed systems. The Eastern Province is categorized as agro-ecological region II (see Figure 3.1, the provincial capital of Chipata is indicated). The Eastern Province is the country's region with the highest crop potential (Siegel, 2008) and it is therefore also known as the national 'maize basket' (Aregheore, 2014). The Eastern Province is a plateau with flat to gently rolling landscapes on altitudes ranging from 900 to 1 200 m above seas level. The growing season lasts from November to April, with most of the annual rainfall of about 1 000 mm falling between December and March (Simukuko *et al*., 2007). Major agricultural activities are the cultivation of maize and groundnuts as well as a wide range of other crops and livestock keeping.

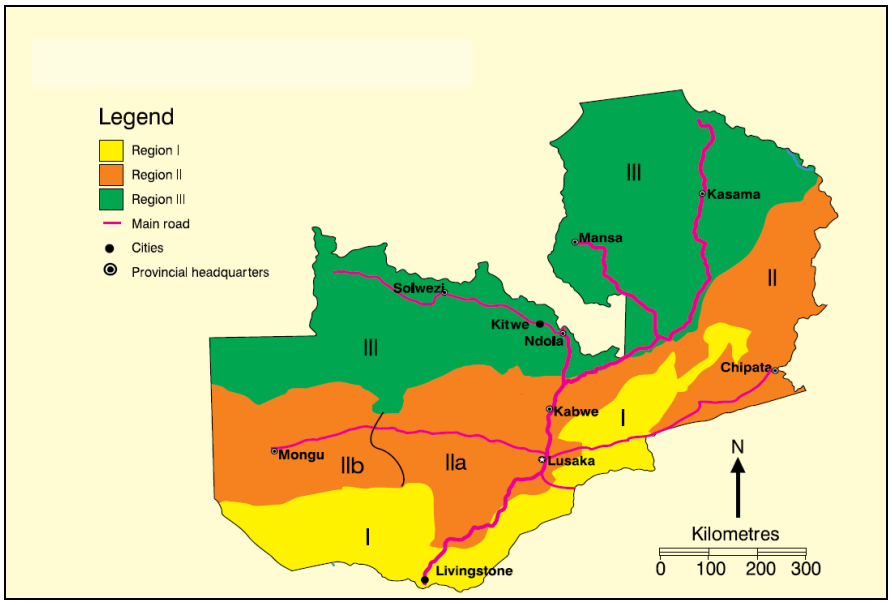

Figure 3.1. The Agro-Ecological Regions of Zambia. CFU, 2007

Despite its high agricultural potential, the Eastern Province is one of the poorest regions in Zambia, with the majority of its population living below the US$1/day poverty line. The Eastern Province also has a higher population density (24 people/km²) than the national average (19 people/km²) resulting in comparatively lower land availability (Aregheore, 2014).

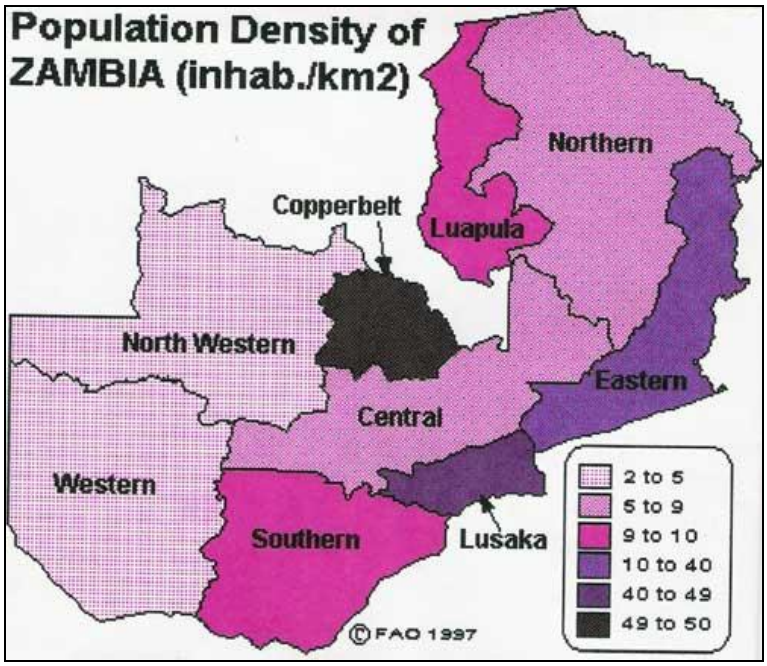

Figure 3.2. Population density in the different Zambian provinces. DFID, 2002

Based on their high potential for agricultural production and the high poverty rates, seven camps within three districts of the Eastern Province – Chipata, Katete and Lundazi - were selected as intervention sites for Africa RISING SIMLEZA project activities. The intervention sites are illustrated in the map in Figure 2.2.

4. Description of local farming systems

4.1 Common features of local farming systems

According to the SIMLEZA baseline survey, on average smallholder farmers in the Eastern Province (Chipata, Katete and Lundazi) possess 5 hectares of land, of which 3.5 ha are cultivated. They plant 3.5 different crops: typically maize, groundnuts and sunflowers. Farmers also grow sweet potatoes, soybeans, cotton, pumpkins, tomatoes, beans, cowpeas, bananas, cabbage, cassava, rape, sugarcane and tobacco (crops are listed in the order of their frequency). Table 4.1 below illustrates the ranges of yields per crop according to the detailed characterization survey.

Table 4.1. Crops grown and yield ranges.

Crop	No. of farmers	Yield Range (kg/ha)	Average Yield (kg/ha)
Hybrid maize	13	625 – 5 909	2 785
Groundnut	12	144 - 900	549
Sunflower	9	106 – 1 125	537
Sweet potatoes	5	1 400 – 8 500	4 385
Soybeans	4	167 - 666	396
Cotton	4	200 – 2 000	1 244
Pumpkin	4	100 - 990	658
Tomato	4	500 – 5 000	2 167
Beans	3	250 - 500	357
Local maize	3	625 - 958	778
Cowpeas	2	16.5 - 42	29
Banana	1		1 200
Cabbage	1		20 000
Cassava	1		12 500
Green maize	1		3 333
Oranges	1		220
Rape	1		625
Sugarcane	1		9 000
Tobacco	1		1 975

For comparison: The hybrid maize yield at the agricultural research station Msekera (Chipata) is 3 642 kg/ ha. Research station yields are generally higher than those of farmers.

The labor inputs per hectare are presented in Table 4.2, which provides an overview for selected crops. Labor inputs for soybeans were lower than for maize, while the labor inputs for

groundnuts were more than double as high than those for maize. According to experts of the SIMLEZA project and staff at Msekera research station, legume crops generally have higher labor requirements than the maize crop. Among the legumes, when comparing the soybean with the cowpea crop, cowpeas are more labor intensive due to several rounds of pickings as well as the harvesting of the leaves as the second crop product, besides the peas, for human consumption. While maize and cowpea seem to be an attractive intercrop and the combined labor requirement was reported to lie below the sum of those for the single crops, intercropping maize and soybean can lead to light competition between the crops and considerable reduction in yields due to a necessary adjustment in crop spacing.

Table 4.2. Labor requirements recorded for selected crops during detailed characterization.

Farm ID	Hybrid maize	Soybean	Groundnut
	Labor hours/ha	Labor hours/ha	Labor hours/ha
Kapara 1	1 750		890
Kawalala 1	154	353	4 970
Chiparamba 2	303		1 027
Kafumbwe 2	312		263
Vuu 2	858		1 723
Hoya 3	335	120	299
Kapara 3	971		943
Kawalala 3	1 339		2 631
Chiparamba 4	362		1 715
Kafumbwe 4	237	732	
Hoya 4	277		195
Vuu 5	661	246	
Chanje East 5	383		945
Kawalala 5	279		352
Average	**587**	**363**	**1 329**

On average 22% of the area farmers operate is cultivated with legumes such as common beans, soybeans, pigeon peas, groundnuts or cowpeas. The farmers reported to have on average 12 years of experience in growing legumes, which seems to imply that farmers have a wealth of experience in legume cultivation and that their motivation for adoption or non-adoption could be quite deeply rooted. Giving scores to different crops in order to evaluate the farmers' satisfaction with these soybeans reached a higher score than maize and cowpeas.

Besides the crops listed above, there are typically also some fruit trees, such as avocado, mango or orange trees on or around the farmers' fields. Farmers in the region own on average 3.1 Tropical Livestock Units, made up of 1.6 goats, 0.4 sheep, 3.2 cattle, 12 chickens, 0.2 beehives and 3.3 pigs (2 goats, no sheep, 3 cattle, 12 chickens, no beehives and 3 pigs).

According to the soil samples taken during the detailed characterization survey, the soils in the intervention sites are mostly sandy soils or sandy loams. The pH values range between 5.60 and 7.12, which correspond almost exactly to the range of values that soybeans grow best on (5.8 – 7.0 according to the NSRL, 2014). Cowpeas are reported to require soil conditions with a pH between 5.6 and 6 (MoA DAFF, 2011). A few farms, mainly in Lundazi, are above this value and might face lower yields (*ceteris paribus*). The measured organic matter content ranges between 0.66 – 4.57% and together with the pH these values were directly inserted into the Farm DESIGN model with an impact on the nutrient balance of the farms. An overview of the measured local soil characteristics is given in Table 4.3 below.

Table 4.3. Soil characteristics of the samples taken in the detailed characterization.

Farm ID	Texture	OM %	pH H_20	P mg/l	P-tot %	N ppm	N-tot %
Farms in Chipata							
Chanje East 5	sand	3.80	5.96	2.39	0.0282	8.606	0.1059
Chiparamba 2	sandy loam	4.57	5.82	2.14	0.0248	11.015	0.1339
Chiparamba 4	sandy loam	3.13	6.11	5.82	0.0721	7.000	0.0883
Kapara 3	sandy loam	3.89	5.96	5.09	0.0625	9.847	0.1234
Kapara 1	sand	2.71	6.11	2.11	0.0253	7.584	0.0953
Farms in Katete							
Kawalala 1	sand	1.52	6.1	1.14	0.0129	4.007	0.0496
Kafumbwe 4	sand	0.84	6.14	2.05	0.0244	1.671	0.0209
Kafumbwe 2	sand	0.66	6.54	1.03	0.0112	1.817	0.0219
Kawalala 5	sand	3.24	6.18	2.07	0.0245	7.876	0.0978
Kawalala 3	sand	3.50	6.13	3.46	0.0418	9.044	0.1125
Farms in Lundazi							
Hoya 3	sand	1.47	7.12	1.89	0.0224	3.058	0.0382
Hoya 4	sand	1.02	5.60	1.34	0.0158	2.693	0.0343
Vuu 5	sand	0.95	6.68	1.79	0.0208	2.182	0.0268
Vuu 2	sand	1.24	6.51	2.19	0.0255	3.715	0.0453
Averages		**2.32**	**6.21**	**2.47**	**0.03**	**5.72**	**0.07**

4.2 Differentiation of farming systems into farm types

Based on the key variables listed in Section 2.3 the local farming systems were grouped into the following farm types (Table 4.4):

- Type 1: Low Resource Endowed, Most Labor for Land Preparation, Legume Growers, Most Food Insecure
- Type 2: Low Resource Endowed, Most Labor for Weeding, Few Legumes Grown
- Type 3: Medium Resource Endowed, Legume Growers, Highest Relative Animal Income
- Type 4: Medium to High Resource Endowed, Highest Off –farm Income
- Type 5: High Resource Endowed, High Crop and Animal Income

Table 4.4. Average characteristics per farm type.

Farm Types	1	2	3	4	5
	Household Characteristics				
Household size	6	6	7	8	9
	Land use				
Cultivated land area (ha)	2.8	2.9	3.4	5.9	14
No. of crops	3	3	4	4	5
Growing Cash Crop(s) in%	62	70	72	74	82
	Livestock				
TLU	1	1.6	2.4	4.1	10.7
Cattle	1	2	2	4	13
Goats	1	1	2	2	4
Sheep	0	0	0	0	1
Pigs	2	3	3	4	6
Chicken	9	7	12	17	16
	Food Security				
Farms (%) facing food shortage throughout the year or occasionally	35	29	25	17	8
	Residue Use				
Residues as green manure	52	58	52	57	57
Residues for livestock	23	21	24	20	24
	Income sources and amounts				
Off farm Income (%)	0.32	0.26	0.23	0.43	0.08
Crop income (%)	0.64	0.69	0.70	0.53	0.87
Animal Income (%)	0.04	0.05	0.07	0.03	0.05
Total Revenues (ZMK)	2,599,522	2,898,401	4,422,041	17,079,912	24,358,112
Revenues per person (ZMK)	424,564	460,064	659,416	2,190,294	2,842,253

Farm Types	1	2	3	4	5
	Labor cost and allocation				
Total labor (person) days per year	334	334	637	774	1 031
Labor days per hectare	119	115	185	131	73
Labor (%) for land preparation	32	11	15	13	15
Labor (%) for weeding	24	46	34	29	27
	Legume related Information				
Area (% of total) cultivated with Legumes	24	14	27	15	15
Year of experience growing legumes	4.5	3.9	8.7	4.7	8.9

The detailed characterization provided data on crop yields. Table 4.5 lists the yields of the most common crops achieved by the different farm types. It is visible that farm types 1, 2 and 3 (low to medium resource endowed farms) typically achieve lower yields than farms of type 4 and 5 (high resources endowed farms). Exceptions are groundnut, soybean and sunflower yields. The high average yields are the result of one type 1 farmer who probably provided us with overestimated[7] figures (1 728 kg/ha for groundnuts, 500 kg/ha for soybean and 750 kg/ha for sunflowers). Linking these results back to the indicator system for sustainable intensification (see Figure 1 in Section 1.4.2), we can see that concerning farm productivity the low resource endowed types are less sustainable than the higher resources endowed types: they have smaller farm areas (see Figure 4.1) and achieve lower yields per hectare. Table 4.6 further demonstrates that farm types 1, 2 and 3 generally have higher labor inputs per hectare. This seems to be associated to the greater number of tools and draft animals available to the higher resource endowed farms (see also Figure 4.2). This has naturally also an impact on farm profitability, as reflected by the revenues per farm type as provided in Table 4.4.

[7] The male household head seemed to have a tendency to exaggerate on his assets: While he claimed to own several pigs, 10 chickens and 1 calf, the separate interview with his wife revealed that 3 pigs had died and only one was left. She also reported that all the chickens died and the calf was not born yet. This farm was not chosen for an exploration and a detailed analysis but it is a great example how gender considerations impact the quality of agricultural research and hence also the farming systems analysis.

Table 4.5. Crop yields per farm type.

Crop	Variety	Improved / Traditional	Yield / ha	Evaluation	Farm type
Beans	Kabulangata	improved	320	Good	2
	Red	improved	250	Average	4
	Katyetye	traditional	500	poor	5
Cowpeas	Unknown	Unknown	17	Poor	1
	local	traditional	42	Poor	4
Groundnut	MGV-5	improved	1086	Poor	1
	Chalimbana	traditional	294	Poor	2
	Cruisa	improved	356	Good	2
	Chalimbana	traditional	424	Average	3
	Unknown	improved	444	Poor	3
	local	traditional	204	Poor	4
	MGV-4	improved	900	Unknown	4
	Gamuromo	improved	900	Good	5
	MGV-4	improved	180	Poor	5
Soybeans	Lukanga	improved	500	Unknown	1
	Unknown	improved	167	Unknown	3
	Unknown	Unknown	666	Average	4
	Local	traditional	250	V Poor	5
Sunflower	Merica	improved	750	Average	1
	Unknown	traditional	106	Poor	2
	Unknown	improved	379	Unknown	2
	Unknown	traditional	128	Poor	3
	Merica, Saona	improved	813	Unknown	4
	Merica	improved	750	Poor	5
	Unknown	Unknown	1125	Good	5
Hybrid maize	Various	improved	1439	Poor - Average	1
	PAN 53	improved	1698	Poor - Average	2
	PAN 53, DK	improved	2432	Unknown	3
	Various	improved	3590	Average - Good	4
	Various	improved	2611	Average - Good	5
Local maize	Unknown	traditional	750	Poor	2
	Unknown	traditional	958	Unknown	3
	Local	traditional	625	Average	4

Table 4.6. Farm type specific labor inputs for selected crops recorded during the detailed characterization.

Farm type	Hybrid maize	Soybean	Groundnut
	Labor hours/ha	Labor hours/ha	Labor hours/ha
1	952	353	2 930
2	491		1 004
3	882	120	1 291
4	292	732	955
5	441	246	649

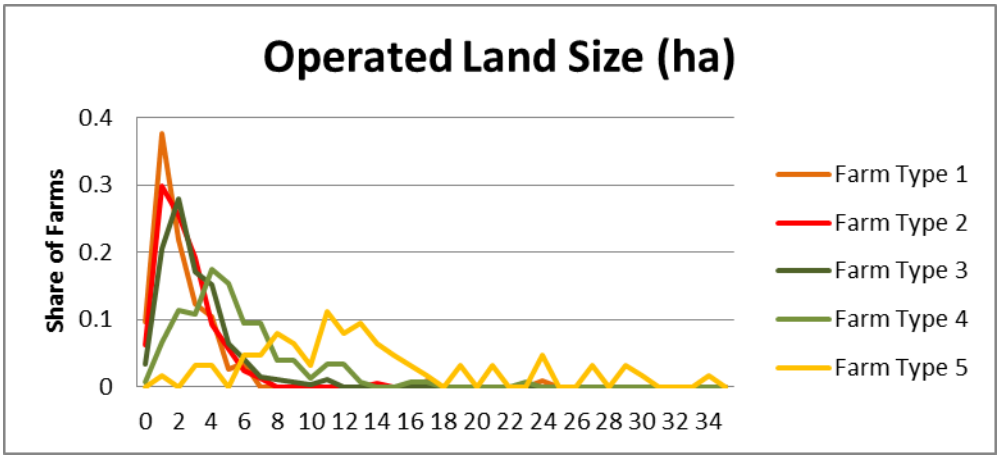

Figure 4.1. Operated land size (ha) per farm type
Source: SIMLEZA baseline survey, 2011

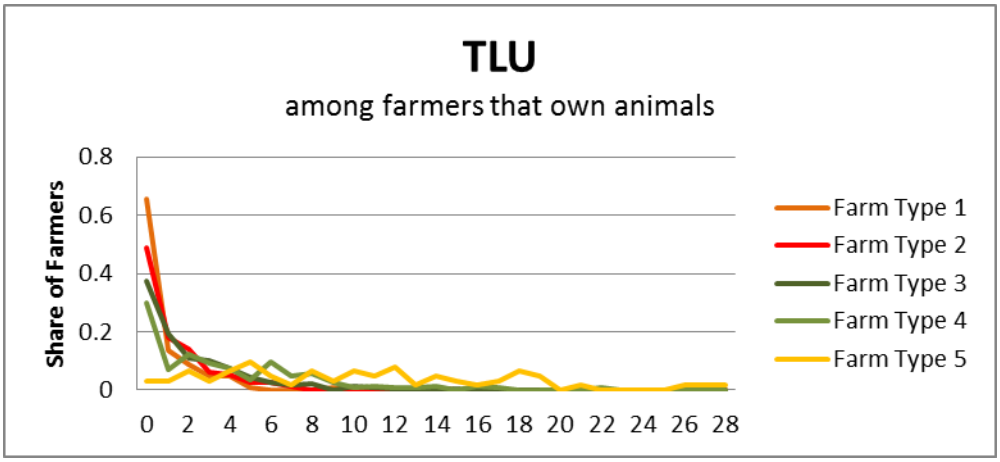

Figure 4.2. Tropical Livestock Units per farm type

The distribution of farm types per camp is illustrated in Figure 4.3, which shows that in Kafumbwe (K) and Chiparamba (C) there is a high prevalence of type 1 farms, while in Vuu (L),

Hoya (L) and Kawalala (K) type 3 farms dominate in number. Type 4 farms are most frequent in Kapara (C), while type 5 farmers have the highest relative frequency in Chanje (C). The spatial distribution of farm types constitutes important hints for later farm type specific targeting activities.

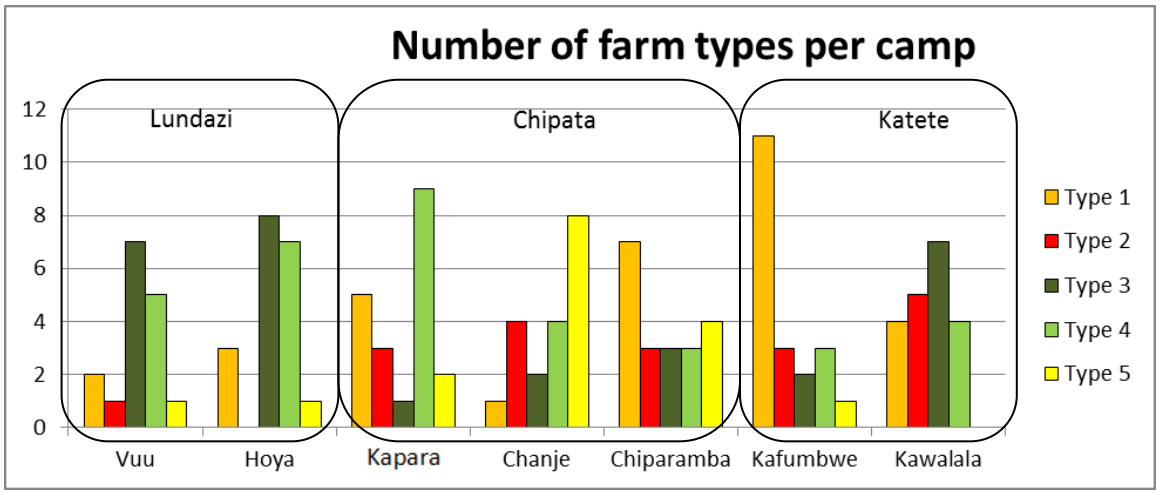

Figure 4.3. Number of farm types per camp (AR SIMLEZA intervention site).

The following subsections will provide a detailed description of the individual farm types and an example for a farm that was chosen for a later in-depth farming systems analysis, including a diagnosis of its current economic, social and environmental performance, the effect of SIMLEZA-specific entry points and an exploration to identify alternative farm configurations that would change the systems towards a sustainable intensification as defined in Section 1.4.2.

The farm types were built from the SIMLEZA baseline survey, which comprised farms in Chipata, Katete und Lundazi – also including different camps than the intervention sites. The farm type averages provided in Table 4.4 are derived from the values for all camps, but the camp specific averages might occasionally vary from the regional mean, hence a small paragraph in the following subsections will show the differences between the regional averages and those for the intervention sites.

*4.2.1. **Farm type 1**: Low resources endowed, most labor for land preparation, legume growers, most food insecure*

Regional Averages: Farms of this type have an average household size of 6 and an average operated farm area of 2.8 ha. On average farmers of this type grow 3 different crops and 35% of the farm households face occasional food shortage or food shortage throughout the year. 24% of the operated land is used to cultivate legumes. Farmers of type 1 possess on average 4.5

years of experience in growing legumes. On a scale from 1 to 5, farmers rate their legume varieties as good (score: 4). 62% of farmers of type 1 grow cash crops. Most of the crop residues generated are used as green manure (52%), are burnt on the field (24%) or are used as livestock feed (23%). Concerning labor inputs, farms of type 1 reported an average of 334 person days per year, allocated mostly to land preparation (32% of total labor days), followed by harvesting (29%), weeding (24%) and shelling/threshing (15%).

Farms of type 1 possess on average 1 goat, no sheep, 1 cattle, 9 chickens and 2 pigs.

Concerning farm revenues: The annual farm revenue per person was determined as about 425 000 ZMK (US$ 80 in March 2012), mainly derived from crop income (64%), followed off-farm income (42%) and animal income (4%). Most of the farm expenses are attributable to fertilizer (60% of total costs), followed by seed cost (20%), hired labor (7.4%) and the cost for hiring oxen (6.3%).

Comparison of types: Farms of type 1 have the smallest operated land size and the greatest average walking distance to their fields. They possess the lowest number of TLUs (only in chickens they own more animals than farm type 2). This farm type also has the lowest share of farmers growing cash crops and the highest share of farming households reporting food insecurity. Farmers of type 1 cultivate a relatively large proportion of their fields with legumes. Among all farm types, type 1 also spends the largest proportion of its expenses on seeds. Farm type 1 and farm type 2 are quite similar in household size, operated area, crop diversity, per head income and total labor inputs, but a striking difference can be observed in their labor allocation: While type 1 spends most labor on land preparation, farm type 2 allocates least labor to it and more to weeding. This might be associated to the higher number of cattle owned by farms of type 2, able to assist with land preparation (a weak negative linear correlation has been determined between the number of cattle owned and labor allocation to land preparation). This difference might also be associated to the high expenses for herbicides by farm type 1, reducing the labor requirements for weeding and shifting the relative weight towards land preparation.

Averages at the AR-SIMLEZA intervention sites (Camps[8])*:* In the AR-SIMLEZA intervention sites, 16 farms of type 1 were captured in the baseline survey. In the AR-SIMLEZA intervention sites, the revenues per person[9] are higher than the regional average (548 000 ZMK), mainly due to a higher total crop income (803 000 ZMK more) and a slightly higher animal income (28 000 ZMK), while the off-farm income is lower (40 000 ZMK lower). On average, farms of type 1 in the intervention sites allocated less labor to weeding (14%) and more labor (24%) to shelling and threshing. In the intervention sites, farms of type 1 cultivated a slightly greater area (26%) with legumes than the regional average (24%). They also indicated to have 1.25 years less experience with growing legumes. In the intervention sites 4 different crops are planted on average and the

[8] Camps in Chipata: Kapara/Kapala, Mtaya/Chiparamba, Chanje
Camps in Katete: Kawalala, Kafumbwe
Camps in Lundazi: Hoya, Vuu

[9] The per head figure is a hypothetical indication of revenues in order to relativize monetary resources according to family size

share of households facing food shortages is with 31% slightly lower than the regional average of 35%. Within the intervention sites also a slightly greater share of crop residues incorporated into the soil (56%). In the intervention sites about 56% of the costs are associated to the purchase of fertilizer, 17% are spent on seeds, 11% of oxen and 8.5% on hiring labor. Apart from the deviations described above, the values in the intervention site do not show significant deviations from the general description of regional farm type 1.

Case study from the detailed characterization: For the whole farming systems analysis we chose a type 1 farm from the Kapara camp in the Chipata district. The farm was chosen since its features matched best with the peculiarities of this farm type, e.g. the farmer grew a high share of legumes and reported a higher amount of labor for land preparation than for weeding.

The pictures in Figure 4.5 and 4.6. provide an impression of the type 1 farming system.

Figure 4.5. Farm type 1 housing area and graneries.

Figure 4.6. Farm type 1 – view on their tobacco field and the surrounding landscape.

This farm consists of 15 family members, of which eight contribute to farm labor. None of the family members pursue any off-farm work, hence the whole family solely depends on their farming income. Together, the family uses 4 111 labor hours: 98% of these on crops, 1.2% on maintenance of farm infrastructure and 0.8% on herding their animals. Exclusively family members cover the relatively high labor inputs, since hired labor is not affordable. They cultivate all their fields by hand with a hoe, they grow their crops in ridges, they perform crop rotation and they mulch their fields – fulfilling two of the three criteria for conservation agriculture. The area they own measures around 3.2 hectares of which 1.2 hectares are currently fallow. On the remainder they cultivate an intercrop of maize, cowpea and pumpkin (1.2 ha), groundnut (0.4 ha) and tobacco (0.4 ha, see also picture in Figure 4.6). They own 2 pigs and 4 chickens, which are fed with maize bran. They bought, so far, 2 additional bags of maize bran to feed their animals. They collect the pig manure from the Kraal and apply it to the maize field (about one 50 kg bag per year). The chicken manure is too little to be collected and applied, they reported. The husband manages the pigs, while the wife manages the chickens. Chickens are sold while the eggs are left for hatching. All the crop residues are hence left in the fields and are either grazed by external animals after the harvest or remain in the field as mulch. The farming family is interested in keeping an ox for ploughing, but an ox is too expensive for them to purchase at the moment. When asked what other crops they would like to cultivate, they indicated sunflower and soybeans. For sunflowers they reported that good quality seeds were too expensive and that the local one did not provide acceptable yields. They already tried to cultivate soybeans on a small piece of their land. It grew well, but it required too much labor, so they did not continue to grow it. As external inputs, the farming family fetches about 6 oxcarts of firewood from the surrounding environment and they buy 3 bags of Compound D, 2 bags of Urea and some pesticide for the tobacco field. They own a machete, two axes, one sickle, nine hoes, one winnower and three bicycles.

*4.2.2. **Farm type 2**: Low resources endowed, most labor for weeding, few legumes grown*

Regional Averages: Farms of this type have an average household size of 6 and an average operated farm area of 2.9 ha. On average farmers of this type grow 3 different crops and 29% of the farmers face occasional food shortage or food shortage throughout the year. 14% of the operated land is used to cultivate legumes. Farmers of type 2 possess on average 3.9 years of experience growing legumes. On a scale from 1 to 5, farmers rate their legume varieties as good (3.7). 70% of farmers of type 2 grow cash crops. Most of the crop residues that are generated are used as green manure (58%), as livestock feed (21%) or are burnt on the field (19%). Concerning labor inputs, farms of type 2 reported an average of 334 person days per year, allocated mostly to weeding (46%), then followed by harvesting (31%), by shelling/threshing (12%) and by land preparation (11%).

Farms of type 2 possess on average 1 goat, no sheep, 2 cattle, 7 chickens and 3 pigs.

Concerning farm revenues: The annual farm revenue per head was determined as about 460 000 ZMK (US$ 86 in March 2012), derived mainly from crop income (69%), followed off-farm income (26%) and animal income (5%). Most of the farm expenses are attributable to fertilizer (55% of total costs), followed by seed costs (18%) and hired labor costs (11%). 8.4% of the total costs are spent on hiring oxen for land preparation and 8.3% on transportation for marketing crop products.

Comparison of types: Farms of type 2 are relatively small in family size, operated land area and animal numbers. Concerning animal numbers, the number of chicken and goats is low while the number of sheep, cattle and pigs are intermediary values as compared to the other farm types. Compared to farm type 3, they only use half of the total labor input, spent 53% less on hired labor and on average their income per head is 24% lower. Among all farm types, type 2 spends the highest share of labor on weeding and the lowest shares on land preparation as well as on shelling/threshing. The high labor inputs for weeding are likely associated to the fact that this farm type has the lowest expenses on herbicides per hectare among all farm types. The low relative labor inputs on land preparation are possibly associated to the fact that this farm type evinces the highest expenses for hiring oxen: 18 000 ZMK per hectare. Compared to other farm types, farms of type 2 grow a relatively low number of different crops and are more food insecure than farms of type 3, 4 and 5. Compared to farm type 3, they only assign half as much land to the cultivation of legumes, they have only half of the years of experience with legumes and rate the legume varieties as worst among all farm types. Among all farm types, they also have the lowest satisfaction with their maize varieties (a score of 3.6).

AR-SIMLEZA intervention sites (Camps): In the AR-SIMLEZA Intervention sites, 31 farms of type 2 were captured by the baseline survey. The revenues per head are slightly lower than the regional average (357 000 ZMK), mainly due to the lower average off-farm income (656,000 Zambian Kwacha lower), the lower crop income (407 000 ZMK lower) and lower animal income (44 000 ZMK lower). In the intervention sites, farms of type 2 cultivated a smaller area (10% of their total operated land) with legumes than the regional average . They however indicated to have a slightly longer experience with growing legumes (4.2 years). On average and the share of households facing food shortages was 19% (10% points below the regional average). Within the intervention sites a greater share of crop residues are used as green manure (65%) and livestock feed (26%). Apart from the deviations described above, the values in the intervention site do not show significant deviations from the general description of regional farm type 2.

Case study from the detailed characterization: For the whole farming systems analysis we chose a type 2 farm from the Kafumbwe camp in the Katete district. The farm was chosen since its features matched best with the peculiarities of this farm type, e.g. relatively little legumes are grown and much more labor is spent on weeding (38%) as compared to land preparation (9%). The pictures in Figure 4.7 and 4.8 provide an impression of this type 2 farming system.

Figure 4.7 Farm type 2 housing area.

Figure 4.8 Farm type 2 pig kraal.

This farm has six family members, of which five contribute farm labor. The male household head earns some off-farm income being a shoe-maker (about 200 ZMW per year) and one of the family's sons herds animals and will be rewarded with a cow after 3 years of work. The family does most of the farm work themselves, but they pay somebody for herding their two bulls. Because they own two bulls they plough all their fields using these animals. They do have ridges on their fields and they also rotate their crops, fulfilling two of the three criteria for conservation agriculture (minimum tillage being the third one). They have a total farm area of about two hectares: one field with local maize (1 ha), one with sunflower (0.25 ha), one with cotton (0.25 ha), one with groundnuts (0.25 ha) and a dimba – a vegetable garden – where they grow sugarcane (0.03 ha), pumpkins (0.003 ha), tomatoes (0.003 ha) and rape (0.0003 ha). Except for the tomatoes (80%) the cotton (100%) and some of the sugarcane they keep all the crop products for home consumption. In terms of animals, they own one pig and the two aforementioned bulls. The pig is usually in the stable while the bulls are herded for grazing for about 10 hours per day off-farm. The kraal manure is completely collected and applied to the dimba. The family would be interested in keeping goats, since these are perceived as being quite resistant to diseases. The family previously had chickens but they died from a disease (possibly

Newcastle). He would also like to buy cows, but just like the goats, these purchases are currently beyond his budget. When asked what other crops the family would like to grow, they responded that they would like to buy hybrid seed for maize, but that the seed was too expensive for them.

In terms of external inputs to the farm: the family collects about 100 kg of firewood per month from the surrounding environment and they buy agricultural chemicals for use on cotton from the company that supplied them with the cotton seed. This farming family does not use fertilizer.

The family owned a machete, a sickle, four hoes, a winnower, a yoke and a bicycle.

*4.2.3. **Farm type 3**: Medium resources endowed, legume growers, highest relative animal income*

Regional Averages: Farms of this type have an average household size of 7 and an average operated farm area of 3.4 ha. On average, farmers of this type grow 4 different crops and 25% of the farmers face occasional food shortage or food shortage throughout the year. 27% of the operated land is used to cultivate legumes. Farmers of type 3 possess on average 8.7 years of experience growing legumes. On a scale from 1 to 5, farmers rate their legume varieties as good (4.3, which is the best score given among all farm types). 72% of farmers of type 3 grow cash crops. Most of the crop residues that are generated are used as green manure (52%), as livestock feed (24%) or are burnt on the field (24%). Concerning labor inputs, on average farms of type 3 use 637 person days allocated in equal shares (each 34%) to weeding and harvesting, while 17% of the total labor input on the farm is spent on shelling or threshing and 15% on land preparation. Farm type 3 has the highest number of labor days per hectare (185) among all farm types.

Farms of type 3 possess on average 2 goats, no sheep, 2 cattle, 12 chickens and 3 pigs.

Concerning farm revenues: The annual farm revenue per person was determined as about 660 000 ZMK (US$ 124 in March 2012), mainly derived from crop income (70%), from off-farm income (23%) and from animal income (7%). The animal income per TLU unit is relatively high (about 148 000 ZMK per TLU unit) indicating a high amount of livestock sales. Most of the farm expenses are attributable to fertilizer (57% of total costs), followed by seed costs (15%) and hired labor costs (14%). 6.8% of the costs are spent on transportation for marketing crops and 5% on hiring oxen for land preparation.

Comparison of types: Farms of type 3 have a medium family size, a medium farm size, intermediary animal numbers as well as an intermediary income compared to the other farm types. Farm type 3 on average cultivates the greatest shares of their land with legumes. They have long experience with growing legumes and report the highest score of satisfaction with

their legume as well as maize varieties (despite their intermediary expenses for seeds). Farm type 3 also has the highest expenses for manure per hectare (335 ZMK per year) and has the second highest expenses for hired labor among all farm types. Farm type 3 has the highest total labor inputs per hectare (185 person days per hectare, which is 2.5 times more than farm type 5, the type with the lowest inputs per hectare). This farm type might be interesting for learning about farmer reasons for adopting legumes, about best practice and how to overcome obstacles as reported by other farmers (likely of different farm types).

***AR-SIMLEZA intervention sites (Camps)**:* In the AR-SIMLEZA intervention sites, 48 farms of type 3 were captured in the baseline survey. In the AR-SIMLEZA intervention sites, the revenues per head are slightly higher than the regional average (661 000 ZMK), mainly due to a higher off-farm income (305 000 ZMK more) and a slightly higher animal income (33 000 ZMK more). On average, farms of type 3 in the intervention sites allocated slightly less labor to land preparation (13%), more on harvesting (37%) and less on shelling/threshing (15.5%). In the intervention sites, farms of type 3 cultivated an even greater area (28.3%) with legumes than the regional average (27%). They however have 1 year less experience with growing legumes (7.7 years). In the intervention sites, only 3 different crops were planted on average and the share of households facing food shortages is 35%. Within the intervention sites also a greater share of crop residues are burnt (27%) instead of incorporated into the soil (3% less than the regional average). In the intervention sites about 10% more of the expenses are going to fertilizers (68%), and therefore less is spent on hired labor (9%), on hiring oxen (2%) and on transportation (0.07%). Apart from the deviations described above, the values in the intervention site do not show significant deviations from the general description of regional farm type 3.

Case study from the detailed characterization: For the whole farming systems analysis we chose a type 3 farm from the Hoya camp in the Lundazi district. This farm was chosen since its features matched best with the peculiarities of this type, e.g. the farm had a relatively high share of legumes and a relatively high animal income. It further matches perfectly with the regional average farm area (non-type specific). Hence if no farm typology was developed and a farming systems analysis for one ‘smallholder farm’ in the Eastern Province would have been made, this farm could have been selected as a representative example. Comparing the features of this farm to the ones of the other farm types provides an impression of the added value of the farm typology.

The pictures in Figure 4.9, 4.10 and 4.11 provide an impression of this type 3 farming system.

Figure 4.9. Farm type 3 – view on their maize field and the surrounding landscape.

Figure 4.10. Farm type 3 housing area.

Figure 4.11. Farm type 3 – duck and chicken kraal.

This farm has five family members, all of them engaged in farm work, none of them earning any off-farm income. The family provides most of the crop labor, but a non-household member herds their four head of cattle. Since they own two oxen, they plough all their fields with draught power. They use ridges, mulching and crop rotation and thereby also fulfill two of the three practices of conservation agriculture. The farm area they own is 6.7 hectares of which 2 hectares are fallow. Two hectares are cultivated with hybrid maize, 1.5 hectares with soybeans, one hectare with an intercrop of groundnuts and sunflower (a frequently observed combination in the Eastern Province) and a 0.2 ha field is cultivated with sweet potato and cassava close to the homestead. The family sells 100% of their soya yield, 66% of their maize and 70% of their groundnut yields. Sunflower, sweet potato and cassava yields are exclusively used for home consumption. The family would like to grow beans, but they stated both a lack of knowledge and the financial means to start cultivating it. The incentive to grow beans would be to sell them and to increase the income of the family. The residues of their crops are partly given to their animals and partly incorporated into the field as mulch. The farming system includes four goats, two bulls, one cow with calf as well as one chicken. Ten chickens recently died due to the Newcastle disease. The goats are envisioned to be sold and the chickens are mainly used for egg production. The ruminants spend most of the time in an external kraal but do graze for about eight hours per day off-farm. The chicken is typically in the yard for about 10 hours per day and is otherwise in the chicken kraal (see also Figure 4.11). The farmer indicated that he would like to keep ducks and doves, but that he currently lacked the financial means to purchase them.

In terms of external inputs to the farm: the family collects about one oxcart of firewood per month, collected in the surrounding environment. They also purchase six bags of Compound D and six bags of Urea as well as some treatments for the animals.

The family owned a machete, three axes, a sickle, a knapsack-sprayer, a shovel, five hoes, four winnowers, an animal cart, a yoke, an ox-ridger and a bicycle.

*4.2.4. **Farm type 4**: Medium to high resources endowed, highest off-farm income*

Regional Averages: Farms of this type have an average household size of 8 and an average operated farm area of 5.9 ha. On average farmers of this type grow four different crops, 17% of the farmers face occasional food shortage or food shortage throughout the year. 15% of the operated land is used to cultivate legumes. Farmers of type 4 possess on average 4.7 years of experience growing legumes. On a scale from 1 to 5, farmers rate their legume varieties as good (4). 74% of farmers of type 4 grow cash crops. Most of the crop residues generated are used as green manure (57%), are burnt (22%) or used as livestock feed (20%). Concerning labor inputs, farms of type 4 reported an average of 774 person days per year, allocated mostly to harvesting (36%), followed by weeding (29%), shelling/threshing (22%) and land preparation (13%).

Farms of type 4 possess on average 2 goats, no sheep, 4 cattle, 17 chickens and 4 pigs.

Concerning farm revenues: The annual farm revenue per head was determined as about 2 190 000 ZMK (US$ 411 in March 2012), mainly derived from crop income (53%), followed off-farm income (43%) and animal income (3%). Most of the farm expenses are attributable to fertilizer (60% of total costs), followed by the cost for hiring labor (17%) and seed costs (13%). 7.5% of the costs are spent on transportation for marketing crops and 3% on hiring oxen for land preparation.

Comparison of types: Farms of type 4, on average, have by far the highest off-farm income. Whilst having a relatively large family size, farm area, animal number, crop diversity and a high food security, this farm type has the lowest shares of crop and animal incomes among all farm types. Despite the low share of animal income compared to total income, the animal income per TLU unit is the higher than for any other farm types (163 000 ZMK per TLU unit) indicating a high share of the TLU's sales. Farms of type 4 allocate relatively little labor to land preparation, which is possibly associated to the high number of cattle (lowering labor requirements in land preparation). Among all farm types, farm type 4 spends most on hired labor (84,000 Zambian Kwacha per year, corresponding to about 17% of total costs). The latter is likely attributable to the off-farm earning activities of family members.

AR-SIMLEZA intervention sites (Camps): In the AR-SIMLEZA intervention sites, 28 farms of type 4 were captured in the baseline survey. In the AR-SIMLEZA intervention sites, the revenues per head are lower than the regional average (1 745 000 Zambian Kwacha), mainly due to a lower total crop income (2 527 000 ZMK less), a lower animal income (99,000 Zambian Kwacha less) and a slightly lower off-farm income (34,000 Zambian Kwacha less). Within the intervention sites a greater share of crop residues are used as green manure (68%, 10% more than the regional average) instead of burnt (9% instead of 22% in the region). In the intervention sites 66% of the costs are spent on fertilizer while only 12% are spent on hired labor. Apart from the deviations described above, the values in the intervention site do not show significant deviations from the general description of regional farm type 4.

Case study from the detailed characterization: For the whole farming systems analysis we chose a type 4 farm from the Hoya camp in the Lundazi district. This farm was chosen since its features matched best with the peculiarities of this type, which is the relative high share of off-farm income: The male household head works as a driver and the wife as a teacher. They do not own any of the farmland they operate, because they are not from the area and might be required to change their residence due to the wife's job.

The pictures in Figure 4.12. and 4.13 provide an impression of the farm type 4.

Figure 4.12. Farm type 4 housing area and recent maize harvest.

Figure 4.13. Farm type 4 - poultry and fireplace.

This farm comprises eight family members, all of them contributing some labor to the farm. While the male household head only has occasional off-farm commitments as a driver, his wife has a regular off-farm job as a teacher and contributes significantly less farm work. This family hires a lot of labor, since the family can afford it through the stable off-farm income, providing them with an above average overall income. This farm operates a relatively large area of 13.4 hectare: 8.2 ha hybrid maize, 2.5 ha groundnuts, a 1.5 ha intercrop of sunflower and pumpkin and a 1.2 ha intercrop of hybrid maize, pumpkin and cowpea. On a small dimba they furthermore grow some rape, some tomatoes and some onions. They keep all the crop products for home consumption, except for maize of which they keep 24 bags for home consumption and the remainder is sold.

The family owns a variety of animals, namely six oxen, three cows, a calf, five goats, three sheep, eight pigs, four sows, 11 ducks and five chickens. All animals are kept near the homestead except for the pigs, which are kept on another property quite a distance away. The ruminants are kraaled for about 17 hours per day and grazed off-farm for about seven hours per day. The pigs are kept in their stable all the time while the poultry spend 12 hours in their shelter and the remaining 12 hours in the yard. The wife sells about six ducks per year, the remaining animal products (eggs, milk and meat) are kept for home consumption. In addition to the animals they already keep, the family would like to rear guinea-fowl and rabbits, but they do not know how to keep the latter.

In terms of external inputs to the farm: the family collects about 1.5 oxcarts of firewood per month from the surrounding environment. They also purchase 28 bags of Compound D and 30 bags of Urea as well as some medicine for the animals.

The family owns an axe, a knapsack-sprayer, a shovel, five hoes, two winnowers, a yoke, two ox-ridgers, two bicycles and a light delivery vehicle.

*4.2.5. **Farm type 5**: High resources endowed, high crop and animal income*

Regional Averages: Farms of this type have an average household size of 9 and an average operated farm area of 14 ha. On average farmers of this type grow 5 different crops and only 8% of the farm households face occasional food shortage or food shortage throughout the year. 15% of the operated land is used to cultivate legumes. Farmers of type 5 possess on average 8.9 years of experience in growing legumes. On a scale from 1 to 5, farmers rate their legume varieties as good (3.8). 82% of farmers of type 5 grow cash crops. Most of the crop residues generated are used as green manure (57%), are used as livestock feed (24%) or are burnt on the field (17%). Concerning labor inputs, farms of type 5 reported an average of 1031 person days per year, allocated mostly to harvesting (36%), followed by weeding (27%), shelling/threshing (23%) and land preparation (15%).

Farms of type 5 possess on average 4 goats, 1 sheep, 13 cattle, 16 chickens and 6 pigs.

Concerning farm revenues: The annual farm revenue per person was determined as about 2 842 000 ZMK (US$ 533 in March 2012), mainly derived from crop income (87%), followed off-farm income (8%) and animal income (4.7%). Most of the farm expenses are attributable to fertilizer (61% of total costs), followed by seed cost (16%), hired labor (10.2%) and transportation costs (10.1%) for marketing. 2% are spent on hiring oxen for land preparation

Comparison of types: Farms of type 5, have the highest overall revenues, attributable to their significantly higher resource endowment in terms of operated area as well as TLUs. Except for chicken, the numbers of animals are the highest average values among all farm types. Farms of

type 5 also have the highest share of farmers growing cash crops. Farms of type 5 allocate more labor than other types to shelling and threshing, eventually indicating greater diligence and efforts in processing, increasing the market value of their farm products. Farms of type 5 have the greatest number of family members who seem to contribute most of their labor to on-farm activities (concluded from comparatively low off-farm income). This farm type has the lowest amount of labor inputs (in person days per year) per hectare, likely due to the high absolute expenses on herbicides as compared to other farm types. Among all farm types, farms of type 5 have the highest relative and absolute expenses on fertilizers and transportation for marketing. The high crop diversity makes farm households of this type resilient against weather and market price fluctuations, resulting into the lowest share of households with food shortages. Farms of type 5 have the greatest experience in growing legumes among all farm types, but they allocate a relatively low share of their operated area to legume cultivation and gave a relatively low score to their legume varieties. It would be interesting to investigate the reason, since these farms seem to have the space and the capacity to invest in alternative crop combinations.

AR-SIMLEZA intervention sites (Camps): In the AR-SIMLEZA intervention sites, only 6 farms of type 5 were captured in the baseline survey. In the AR-SIMLEZA intervention sites, the revenues per head are slightly higher than the regional average (2 966 000 ZMK), due to higher income from crop sales, animal products and off-farm income. On average, farms of type 5 in the intervention sites allocated slightly less labor to land preparation (9%), but more on shelling/threshing (39%). In the intervention sites, farms of type 5 cultivated a smaller area (8.5%) with legumes than the regional average of 15%. They also indicated to have 2.4 years less experience with growing legumes. In the intervention sites 6 different crops are planted on average and none of the households reported food shortages. Within the intervention sites also a greater share of crop residues was incorporated into the soil (83%, as opposed to 57% on average in the regional sample), but only 11% was fed to animals (instead of 24%). In the intervention sites about 67% of the costs are associated to the purchase of fertilizer, 13% are spent on transportation, 12% of seed and 6.7% on hiring labor. Apart from the deviations described above, the values in the intervention site do not show significant deviations from the general description of regional farm type 5.

Case study from the detailed characterization: For the whole farming systems analysis we chose a type 5 farm from the Kawalala camp in the Katete district. This farm was chosen since its features matched best with the peculiarities of this type, e.g. high profits with no off-farm income as well as a relatively low share of legumes.

The pictures in Figure 4.14 and 4.15. may convey an impression of this type 5 farm.

Figure 4.14. Farm type 5 housing area.

Figure 4.15. Farm type 5 – cattle herd.

This farm comprises 11 family members of which seven contribute to farm labor. They own 23 hectares of which 11.5 are left fallow. Eight hectares are cultivated with hybrid maize, one hectare with cotton, one hectare with sunflowers, 0.5 hectare with groundnuts and a 1 ha vegetable garden (dimba). The family hires some labor for their maize and cotton crops, which are also the only crops this farm sells (85% of the maize and 100% of the cotton are sold). This farm owns 36 cattle (8 bulls, 20 cows and 8 calves as partly visible in Figure 4.15), six pigs, two goats, 20 chickens and 12 doves. The cattle is kept in the kraal for about 16 hours per day and they graze for 8 hours per day. Between November and July, they graze on the fallow farmlands

and between August and October they graze off-farm. The pigs are kept in their kraal all the time while the goats, chickens and doves are confined for 12 hours per day in their shelters and the spend the rest of their time in the yard. The farmer indicated they sold pigs and chickens, while the remaining animal products were indicated to be used for home consumption. The farmer reported they obtained six oxcarts of manure from the kraal, which is used to fertilize the maize fields and the dimba. The farmer also indicated to collect about one 50kg bag of chicken manure that he spreads on his fields as well. They said that they would like to start keeping sheep, but that sheep are not readily available in their area.

In terms of external inputs to the farm: the family imports about one oxcart of fire wood per month, collected in the surrounding environment. They also purchase 15 50kg volume bags maize bran as additional feeds for their pigs. They furthermore purchase 28 bags of Compound D and 28 bags of Urea as well as some herbicides and medicine for the animals.

The family owned a machete, an axe, a pick axe, a knapsack-sprayer, a shovel, six hoes, two winnowers, an animal cart, four yokes, an ox-ridger, a plough, a ripper and two bicycles.

4.3. Summary of farm type specific objectives and challenges

This section provides an overview of challenges and self-reported farm objectives by the interviewees of the detailed farm characterization. The farmers were asked for their general desires concerning additions to the crops they grow and the animals they keep. The farmers were also asked for the main challenges and constraints they faced in farming as well as the constraints regarding specific entry points (changes in their farming system) such as a greater use of residues as mulch or as animal feed, an increase in crop diversity, intercropping, storage of manure and practices of Conservation Agriculture. They were also asked if they would want to expand or reduce their farming area and about their reasons for their choice. The farmers were moreover asked how important it was to them to improve their yields and about the social cohesion in the community (sharing of knowledge and mutual support in times of crisis).

Table 4.4 summarizes the objectives and challenges faced by the farmers of the different farm types. The first entry per farm type always corresponds to the case study chosen for the whole farm analysis and farm exploration. The information in Table 4.4 provides valuable hints on the likelihood and the reasons for the adoption or non-adoption of the suggested SIMLEZA entry points. The objectives and challenges furthermore constitute crucial contextual information for the alternative farm configurations suggested in section 6.

Table 4.7. Objectives and challenges faced by the different farm types

Farm Types	Objectives	Challenges
Farm Type 1	Our case study farm would like to expand its farming area to **grow sunflower and soybeans on** the **additional area**. The farmer thinks that he has lower yields than his neighbors, although having higher yields than them is important to him. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. Hence he seems quite **motivated to try out new farm practices** that promise **higher yields from the same area.**	He would like to grow sunflower and soybeans, but for sunflower **good seed** is too expensive and for soybeans the required extra **labor** is **not affordable**. The obstacle in increasing the number of crops is labor. The farm would like to have an ox for ploughing, but it is too expensive as well. About the residue retention: he would like to incorporate all his residues into the soil, but the **cattle of his neighbor** sometimes **enters his field** and grazes on these. He tried to talk about this with his neighbor but no solution was achieved so far.
	Another type-1 farmer did not have any ambitions to increase or reduce his farm area. He also thinks that his yields are the same as the ones of the neighbor. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. He also indicated that he **would like to grow soybeans** to improve his soil fertility and it provides good yields. He just started to grow them on a small plot. He would also be **interested in growing pigeon peas**. He would also be **interested in keeping sheep**.	The farmer stated that the **labor requirement for higher residue incorporation into the soil is too high**. He **does not intercrop because of the lack of seed**s for the legume integration. He does **not store his manure sealed from air or water because he was unaware** that this would improve the manure quality. He would like to keep sheep but **sheep are not readily available** in his area.
Farm Type 2	The case study type-2 farmer would like to expand their farm area in order to obtain **more food for the growing family**. Compared to his neighbors, this farmer believes that he has lower yields, although it would be important for him to achieve higher yields (status). He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. Hence he seems quite **motivated to try out new farm practices** that promise **more food and higher yields.**	As the main constraint to his farm business he perceives the high **cost of fertilizers**, the **lack of labor**, **lack of ploughing equipment** as well as the temporary unavailability of his wife after her latest childbirth due to complications (caesarian delivery). He believes **that growing intercrops is not beneficial** because the **crops** would **compete for nutrients**. In terms of new crops, he would like to grow hybrid maize but the seeds are too expensive for him. He would like to have goats, chickens and further cattle but he **lacks the financial means** for this at the moment.

	Another type-2 farmer indicated that he would like to **expand his farming area to increase his farm profits**. His yields are the same as the ones of the neighbor in his opinion. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. The farmer would **like to grow soybeans because of the good market** for them. The farmer indicated that he **would be very interested in more knowledge on intercrops and he could imagine implementing them**. The farmer stated that he **would like to keep goats, pigs and chickens.**	The farmer said that he could **not incorporate more residues as green manure** because of the **high associated labor requirements**. He reported that it is a problem that the animals of other farmers enter his fields and eat parts of the **residues (=loss).** He does **not intercrop because he lacks the knowledge** on the importance of doing so. He **cannot increase the number of crops** grown because he would **need more land** for that. He **does not buy goats, pigs or chickens** because he currently **lacks the money for this**.
	The third type-2 farmer indicated that she would like to **expand her farming area to grow further crop types**. She feels that she achieves lower yields than her neighbors, although It is important for her to have higher yields than her neighbors and the relatives. She is however confident that her neighbors would give her honest and valuable advice and she would also provide this to her neighbors if they consulted her about her farming practices. She indicated that **she would like to grow soybeans and common bean**s She knows how to grow it, she has grown these crops before.	The main constraints she faces are the **lack of capital** (and lack of **access to credits**), the high **cost of labor**, the **changes in rainfall patterns** and the high cost of seeds. She also mentioned that **the low soil fertility** was a problem in crop production, also **livestock pests and disease**s and the **high cost of pesticides**. She states that she could not grow a higher number of crops because she lacks the money and the additional labor. She does not store the manure sealed from air and water, but **she had kept the manure in a pit before, but that was too much labor**. She explained that she would like to grow **soybeans and common beans**, but the **seeds are difficult to access (cost) and the labor is too expensive for her.**

Farm Type 3	Our case study type-3 farmer indicated that he would like to **expand his farming area**, to keep this land **for his children** later on (long term perspective and an aspect of social sustainability of the farm business). The farmer would like **to grow beans** to sell them and have more income. This farmer stated that he is **open to suggestions and advice on new crops**. He also would like to rear **ducks and doves**. The farmer thinks that his crop yields are lower than those of his neighbors, although it is quite important for him to achieve better yields. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. Hence he seems quite **motivated to try out new farm practices** that promise **higher yields from the same area.**	This farmer indicated that he **lacks the knowledge of how to grow beans**. He indicated that he does not rear **ducks and doves** because **he lacks the money to buy** them. An obstacle to grow further crops is the **labor constraints**. The farmer thinks that **intercrops will out compete each other and will not perform well**.
	Another type-3 farmer stated that she would like to make better use of her fallow land. The farmer stated that she got lower yields than neighboring farmers, but she said that she **stores the grain better and in the end it seems like she has more grain available** than the other farmers. It is important for her to have higher yields than her neighbors and the relatives. She is however confident that her neighbors would give her honest and valuable advice and she would also provide this to her neighbors if they consulted her about her farming practices. She also reported that s**he would like to grow soybeans and common beans. For** the latter she encountered difficulties in obtaining the seeds and for soybeans he said that it was difficult for her to access the market. She **would like to buy pigs and goats.**	The farmer currently does not use her fallow land because she **lacks the labor force** to do so. She would like to import some organic matter on her farm (more residues on the field) but she would need transportation for that, which she lacks. She cannot increase the number of her crops currently because she **does not have enough labor and the seeds.** She does **not store the manure sealed** from water and air because she **lacks the knowledge of the benefits**.
	The third type-3 farmer indicated that she would like to expand her farm area because **her family is growing and she needs more food**. She thinks that she achieved an average yield, but it is important to her to have higher yields than her neighbors and the relatives. She is however confident that her neighbors would give her honest and valuable advice and she would also provide this to her neighbors if they consulted her about her farming practices. The farmer **would like to grow soybean**.	As the two main constraints the farmer indicated the **sickness of family members** (and their consequential temporary unavailability) and that their **bull died of a disease**. She currently does **not grow soybeans because she lacks the seed, she lacks the money and feels she does not have a big enough field size** for this. She does **not intercrop, because she has no knowledge** about this practice.

Farm Type 4	Our case study type 4 farming family indicated that they would like to expand their farmed area to **harvest more and to become more food secure**. Farming is their main source of income and the male household head indicated to love farming. Compared to other farms in the area he thinks that his yields are higher and this is quite important to him. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices . The family indicated that they would like to **grow beans.** They would like **to rear guineafowl and rabbits.** The farming family would be interested to learn more about better means to store their manure. Hence he seems quite **motivated to try out new farm practices** that promise **more food and higher yields.**	The farming family indicated that they do not grow (many) intercrops because they concentrate on maize and they do not have much knowledge on the technique and the effect of intercropping. The farmer does not grow beans because he states to lack the knowledge on their cultivation. Guinea-fowl need much care and they do not know how to keep rabbits, hence they did not buy them yet.
	Another type-4 farmer indicated that he would like to **expand his farm area to advance the development of his house**. He stated that he achieves average yields although it is quite important to him to have **higher yields (status**). He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices .He **would like to grow cabbage** and would like to keep an **improved breed of pigs.**	This farmer described that the **low soil fertility and the high costs of fertilizers** are the main constraints to farming for him. He does **not grow intercrops because the thinks this is an old style of farming which is bad.** He does not have a higher number of crops because he **does not have more seed**. He does not grow cabbage yet because he lacks the seed. He does not have the improved breed of **pigs** because **he does not know where to obtain them.**
	The third type-4 farmer indicated that he would like to **expand his farm area to attain higher profits** and to buy a car. He stated that he achieves average yields although it is quite important to him to have **higher yields (status**). He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. The farmer **would like to keep pigs and goats**. The farmer also stated that he **would like to grow cotton and soybean.**	This farmer stated that the main challenges are the **high cost of fertilizers and the changing rainfall patterns**. He also mentioned that the marketing system for maize was a disadvantage for his sales (he **thinks he would obtain higher prices if the government would not fix the maize price**). He also mentioned that the **transportation cost for** his crop sales are quite high and **roads are in poor condition.** The farmer stated that he had pigs and goats in the past but they died from a disease. The farmer stated that he **did not grow cotton yet because the price is too low for him.**

Farm Type 5	The case study farmer of type 5 indicated that he would like to **expand his farm area to harvest more maize.** Compared to other farms in the area he thinks that his yields are higher and this is quite important to him. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices .The farmer would like to **keep sheep.**	The main constraints for farming are the **changing rainfall patterns due to climate change**, the **sickness of family members** (and the consequential unavailability of their farm labor), lack of funds and lack of labor. The farmers indicated that he does not expand his land to grow more maize because he does not have enough money to buy the inputs. He **does not grow any intercrops because this is a new concept** to him and he **did not know** much about this before. The farmer does not keep **sheep** yet because they **are not readily available** in the area.
	Another type-5 farmer indicated that he would like to **expand his farming area to grow further crops**. The farmers thinks that he has lower yields than his neighbors, although having higher yields than them is important to him. He is confident that his neighbors would give him honest and valuable advice and he would also provide this to his neighbors if they consulted him about his farming practices. He mentioned that he perceives the **practices of conservation agriculture to improve his farming** business (the yields, the general state of his farm). The farmer indicated that he would be **willing to try** out the **improved manure storage technique** (sealed from air and water). The farmer also stated that he **would like to keep pigs, sheep and rabbits**. The farmer reported that he **would like to grow cowpeas, cotton, cassava, bambara nuts and velvet beans.**	The farmer indicated the high **costs of good seeds, the high costs of fertilizers as well as their unavailability of fertilizers and pesticides** as his main constraints. In addition to these he mentioned that the **change in rainfall patterns** due to climate change was another obstacle. The farmer mentioned that he stopped intercropping due to conservation agriculture. He stated that he **does not have enough land** to grow more crops. The farmer said that he did not grow the desired crops yet because of **labor constraints** and because he would have to reduce his maize or soybean area. The farmer stated that he did not keep the desired animals yet because he **does not know how to keep pigs, how to arrange a shepherd for the sheep and he did not know where to buy the rabbits.**
	The third type-5 farmer reported that she **would like to expand the farm area because her family is growing**. Compared to other farms in the area she thinks that her yields are higher and this is quite important to her. She is confident that her neighbors would give her honest and valuable advice and she would also provide this to her neighbors if they consulted her about her farming practices. The farmer **would like to grow soybeans**.	The farmer reported that the **high cost of fertilizers, the change in the rainfall pattern and the sickness of family members** were the main constraints to farming. She also stated that she did **not grow intercrops because she thought that this would have a negative impact on the yields**. She does not grow a higher number of crops because she **does not have enough labor available.** The manure is in the kraal and taken from there to the field, **hence no improved storage practice is envisioned.**

It is interesting to observe how the motivation of farming shifts between the farm types, from a focus on food security in the lower resource endowed types towards status and material ambitions in the higher resources endowed farm types. Despite all falling under the label of 'smallholder farmers' the farm typology served to reveal the quite pronounced differences within this group of farmers. The suggestion of new farm management practices or of new crops etc. is more likely to happen if they are perceived to be in line with the farmers general motivations: If cowpeas are very nutritious, then highlighting this quality will attract farmer families that seek for an improvement in this respect. If soybeans are known as a cash crop and market access is more difficult (e.g. expensive) than for other crops, then this crop is more likely to be adopted by high resources endowed farmers.

5. Farm type specific evaluation of SIMLEZA entry points

The model Farm DESIGN was used to evaluate the entry points that were proposed by SIMLEZA staff: Based on key indicators for sustainable intensification (higher profit, higher soil organic matter, nitrogen fixation and lower labor requirements) the impact on the different farm types was assessed: it is assumed that the stronger and the more positive the impact, the better the basis for promoting these activities and the more likely the actual adoption by the farmers. Three entry points were tested, namely:

1. **Entry Point 1:** Converting 100% of the area currently allocated to Maize to an intercrop of Maize and Cowpea.

2. **Entry Point 2:** Converting 70% of the area currently allocated to Maize to 35% sole crop Maize after Cowpea and 35% sole crop Cowpea. The current Maize area is kept to 30%.

3. **Entry Point 3:** Converting 70% of the area currently allocated to Maize to 35% sole crop Maize after Soybean and 35% sole crop Soybean. The current Maize area is kept to 30%.

In order to evaluate the entry points the following assumptions were made;

Yields: Recent data obtained from long term trials being conducted by CYMMYT at the Msekera research station in Chipata, eastern Zambia, were used. As these yields were obtained on a research station, where crops are grown under optimum conditions, a reduction factor was calculated per farm based on how much lower the farmers' recorded actual maize yields were compared to the yields for the sole maize at Msekera. This reduction factor was applied to the yields for sole legume crops as can be seen in Table 5.1. In addition, for entry point 1, the reduction in yield due to the effects of intercropping maize and cowpeas were also applied to

the farmer's actual attained yield of maize. The increase in maize yields sown after a legume was estimated using the respective yield increases in the trial results for the rotations of maize following cowpeas and maize following Soybean. The yield figures used can be seen in Table 5.2. The fresh yields of the crop residues were estimated using harvest indices of 47% for maize, 38% for cowpea and 44% for soybean.

Table 5.1. Adjusted yields for maize and predicted yields for sole cowpea and sole soybean crops for different farm types

Farm	Actual maize yield kg/ha	Reduction factor	Sole cowpea yield kg/ha	Sole soybean yield kg/ha
Type 1	1 236	0.6606	319	251
Type 2	625	0.8284	161	127
Type 3	2 975	0.1831	769	605
Type 4	3437	0.0564	888	699
Type 5	1 250	0.6568	323	254
Msekera[1]	3 642	0	941	741

1. These yields were the reference yields to calculate the adjusted yields.

Table 5.2. Adjusted yields for maize cowpea intercrops and sole maize crop following a legume crop for different farm types

Farm	Maize cowpea Intercrop		Maize yield[3] following cowpea kg/ha	Maize yield[4] following soybean kg/ha
	Maize yield[1] kg/ha	Cowpea yield[2] kg/ha		
Type 1	1 175	61	1 409	1 353
Type 2	594	31	713	684
Type 3	2 829	148	3 392	3 257
Type 4	3 268	171	3 918	3 762
Type 5	1 189	62	1 425	1 368
Msekera[5]	3 463	181	4 152	3 987

1. Reduction factor of 4.91%. 2. Reduction factor from Table 5.1. 3. Increase by 14%. 4. Increase by 9.47%. 5. These yields were the reference yields to calculate the adjusted yields.

Labor: As labor data is difficult to assess and as labor requirements vary greatly between farms and farmers, an indication for the appropriate labor requirements for each tested Entry Point crop or crop combination were estimated. Based on our empirical analysis as well as a discussion with SIMLEZA staff, it was assumed that compared to the farmer's recorded maize labor requirement, a sole soybean crop would require 10% more labor, a sole cowpea crop, 20% more labor and a maize and cowpea intercrop 30% more labor.

Cultivation costs: Maize cultivation costs were assumed to be 340 ZMW/ha based on the current market price for 20 kg of maize hybrid seed. Cowpea cultivation costs were assumed to be zero as farmers surveyed during the detailed characterization recycled their cowpea seed. Soybean cultivation costs were assumed to be 400 ZMW/ha based on the current market price for 50kg of soybean hybrid seed.

Crop product destinations: The current 'destinations' (use) of crop products was kept constant such that the home consumed amounts remained the same: if an entry point resulted in shortages, these would have to be supplemented by purchased products. Wherever possible the crop residues were allocated to remain on the soil in the field, maximizing the residue retention, which was another crop/residue management practice suggested by SIMLEZA.

The key indicators used were Operating profit (ZMW/year), Labor requirement (hours/year), Organic matter added (kg/ha/year) and Biological nitrogen fixation (kg/ha/year). The results of the evaluation are presented in Table 5.3 below.

Table 5.3. The percentage increase or decrease in indicators after incorporation of each entry point for each farm type.

Farm type	Before	After Entry Point 1		After Entry Point 2		After Entry Point 3	
Farm Type 1							
Operating Profit	8134	6177	-24.1%	7521	-7.5%	7454	-8.4%
Labor Requirement	0	626	increase	141	increase	67	increase
Organic Matter Added	1223	1334	8.5%	1239	0.8%	1275	3.7%
Biological N Fixation	45	53	17.8%	45	0.0%	46	2.2%
Farm Type 2							
Operating Profit	636	-99	-115.6%	213	-66.51%	61	-90.4%
Labor Requirement	50	144	188.0%	72	44.00%	61	22.0%
Organic Matter Added	1147	1326	15.6%	1208	5.32%	1250	9.0%
Biological N Fixation	39	60	53.9%	47	20.51%	48	23.1%
Farm Type 3							
Operating Profit	5688	4073	-28.4%	4236	-25.53%	3507	-38.3%
Labor Requirement	3023	3225	6.7%	3070	1.55%	3047	0.8%
Organic Matter Added	1449	1610	11.1%	1511	4.28%	1449	0.0%
Biological N Fixation	56	68	21.4%	60	7.14%	61	8.9%

Farm type	Before	After Entry Point 1		After Entry Point 2		After Entry Point 3	
Farm Type 4							
Operating Profit	16432	12360	-24.8%	12904	-21.5%	10107	-38.5%
Labor Requirement	5503	6187	12.4%	5663	2.9%	5583	1.5%
Organic Matter Added	1222	1543	26.3%	1326	8.5%	1369	12.0%
Biological N Fixation	60	85	41.7%	69	15.0%	71	18.3%
Farm Type 5							
Operating Profit	35080	32453	-7.5%	34951	-0.4%	33431	-4.7%
Labor Requirement	360	1028	185.6%	517	43.6%	438	21.7%
Organic Matter Added	710	843	18.7%	796	12.1%	825	16.2%
Biological N Fixation	32	45	40.6%	36	12.5%	38	18.8%

Figures in red indicate an unfavorable, and green a favorable increase or decrease in the indicator

It is immediately noticeable that all entry points tested decreased the operating profit despite the additional sales of the introduced legume crops. In the cases where the farms were currently not selling any maize crop, they were using all they had for home consumption; these farms had to purchase maize to remain at the same level of food security. The lower maize yields that were achieved under intercropping with cowpea (Entry Point 1) meant that these subsistence farmers increased their costs. In addition, farmers that previously recycled their seed (type-2), had additional costs to purchase hybrid seeds as suggested by the model. Thus the greatest reduction in profit is seen with the type-2 farm, which was a subsistence farm that recycled their maize seed. Assuming that this farm would use local recycled maize seed for the intercrop, the cost of the hybrid maize seed would not be present and the operating profit would be 241 ZMW/year, still translating to a 62.1% decrease in profit. This same farm is also not financially compensated for the reduction of 35% of their maize area (albeit at a higher yield) to a legume crop (Entry Points 3 and 4). Financially, the type-5 farm would suffer least of all types from the inclusion of the entry points as this farm is less reliant on their crop production for their income, as their income comes from both livestock and arable farming.

The labor requirements for all farms increased, this would mainly be due to the assumptions made that all entry points required more labor. These assumptions can also be seen by the fact that Entry Point 1 has the most extra labor required followed by Entry Point 2 and the least from Entry Point 3. Types-3 and -4 that already hire much labor 3 023 and 5 503 hours per year respectively have the least relative additional labor required. The type-1 farm that does not hire any labor has the greatest increase when implementing the entry points.

The organic matter added per year increases for all entry points. This is largely due to the additional crop residues that are left on the soil surface. The greatest increase from the type-4 farm is a result of the added organic matter produced by adding additional legume crops in the previously sole maize cropping system. The least increase is from the type one farm, which already leaves most of their residues on the field as they do not have animals to which they would feed them.

The inclusion of more legumes in the farming systems had the effect of increasing the biological nitrogen fixation (BNF) in all farm types and for all entry points. The greatest increases occurred on farms that had the least legumes already incorporated on their farms. For example type-4, where the cropping system was mainly mono-cropped maize. The greater the amount of BNF, the greater yields could be. However, as there is no yield response curve in Farm DESIGN, the additional financial benefits to the farming system from an improved yield are not accounted for.

If we were to assess the degree to which it would be likely that a farm type would adopt an entry point, we can look at the trade-offs that are apparent in Table 5.3.

Type-1 farms have a large increase in required labor, however have no additional profit and the least increase in organic matter added and BNF. Thus it would be likely that they would not adopt these entry points based on this evaluation.

Type-2 farms would have much less profit, however this could be offset by the additional BNF, which could translate into higher yields. However based on this evaluation, adoption of these entry points is also unlikely.

Type-3 farms have the least increase in labor required to achieve greater organic matter additions and BNF. This may make the adoption of these entry points somewhat more likely than the type-1 or type-2 farms.

Type-4 farms also do not have as much more labor requirements than Type-2 or -5 farms, yet have one of the higher increases in BNF. As there are also great increases in the organic matter added, it is possible that these farmers would adopt these entry points more readily than types -1, -2 or -3.

Type-5 farms with low decreases in operating profit have great increases in organic matter and BNF. This comes at the cost of high additional labor requirements. If this labor is readily available at a reasonable price, it is most likely that this farm type would adopt these entry points compared to all other types.

Thus it is apparent that there seems to be a gradient of increasing likelihood of adoption moving from type-1 farms through types-2, -3 and -4 to type-5 farms.

6. Exploration of farm type specific options for sustainable intensification

The model-based explorations have been performed for five farms selected from the detailed characterization interviews in the Eastern Province of Zambia. The results from these explorations are presented in this section. These results give a realistic indication of the potential of the model to explore trade-offs and to identify entry points.

The model aims to find alternative farm configurations using the different decision variables to find configurations that achieve the objectives that have been set. The explorations all used three objectives, namely to maximize farm operating profit, to maximize the organic matter added to the soil and to minimize the farm labor requirements. These three aspects cover the economic, environmental and social dimension of sustainability, as explained in Section 1.4.2. The decision variables used were variable areas of the currently grown crops as well as variable areas of new entry point crops. The current situation of each farm and the associated options for exploration are presented in Table 6.1. The results of the explorations (the solution space, with each dot representing an alternative farm configuration) are visualized in Figure 6.1, 6.2, 6.3 and 6.4 below.

Table 6.1. The current situation and the exploration options for the five farm types.

	Type 1	Type 2	Type 3	Type 4	Type 5
Current Situation					
Farm area (ha)	3.2	2.0	6.7	13.4	23
Crops currently grown	Maize Groundnut Cowpeas Tobacco Pumpkin	Maize Sunflower Cotton Groundnut Sw. Potato Sugarcane Pumpkin Vegetables	Maize Groundnut Sunflower Soybean Sw. Potato Cassava	Maize Groundnut Pumpkin Cowpea Sunflower Pumpkin Vegetables	Maize Sunflower Groundnut Cotton Vegetables
Animals currently owned	Pigs Chickens	Cattle Pigs	Cattle Goats Chickens	Cattle Goats Sheep Pigs Ducks Chickens	Cattle Goats Pigs Chickens Doves
Operating Profit (ZMW/year)	8 134	635	5 880	16 432	35 080
Organic Matter added (kg/ha/year)	1 229	1 147	1451	1 222	710
Labor balance (hours/year)	0	50	3 027	5 503	360
Exploration					
Crop Exploration	Variable areas of 5 new 'entry point' crops; maize cowpea intercrop, sole soybean crop, sole cowpea crop, maize after cowpea and maize after soybean. Variable areas of currently grown crops. Range of non-maize crops restricted between 0 and 70% of total area. Range of maize and maize intercrops between 0 and 100% of total area.				

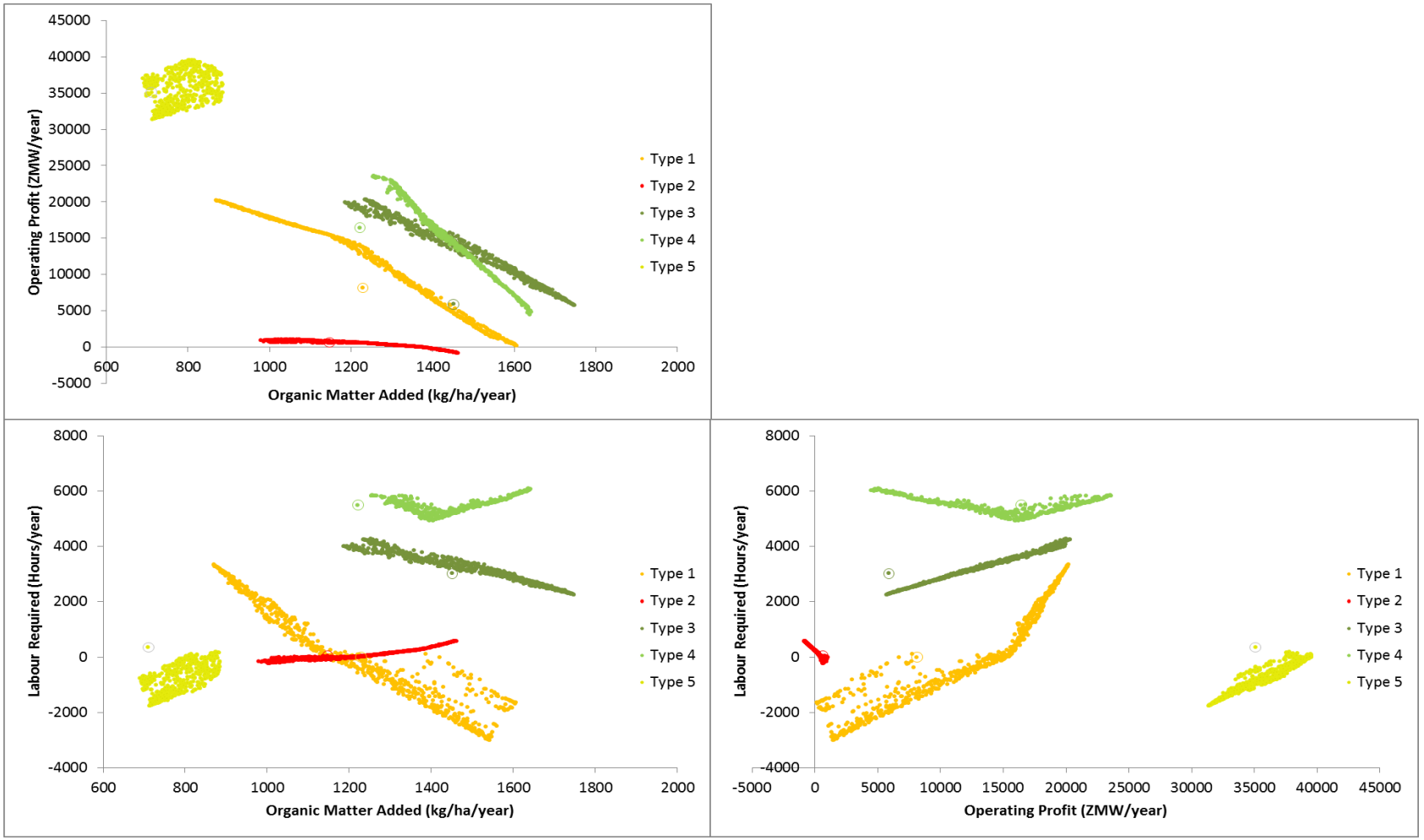

Figure 6.1. Performance of alternative farm configurations in terms of three farmer objectives, for five farm types in eastern Zambia (type-1: orange, type-2: red, type-3: dark green, type-4: light green, type-5: yellow). The points with a circle indicate the performance of the original farm configurations.

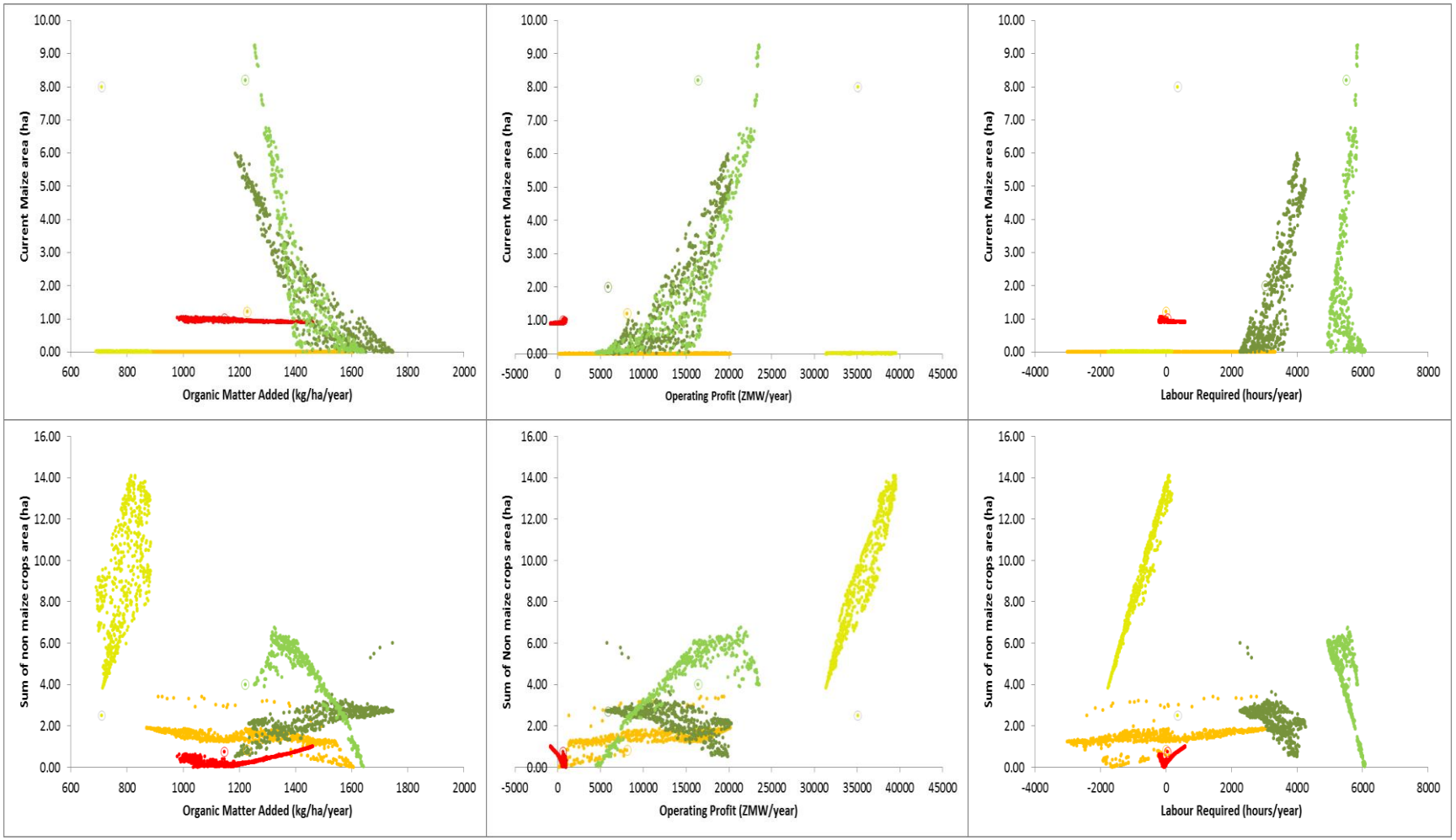

Figure 6.2. Differences in cultivated areas of maize and summed non-maize crops in relation to changes in three farmer objectives, for five farm types in eastern Zambia (type-1: orange, type-2: red, type-3: dark green, type-4: light green, type-5: yellow). The points with a circle indicate the performance of the original farm configurations.

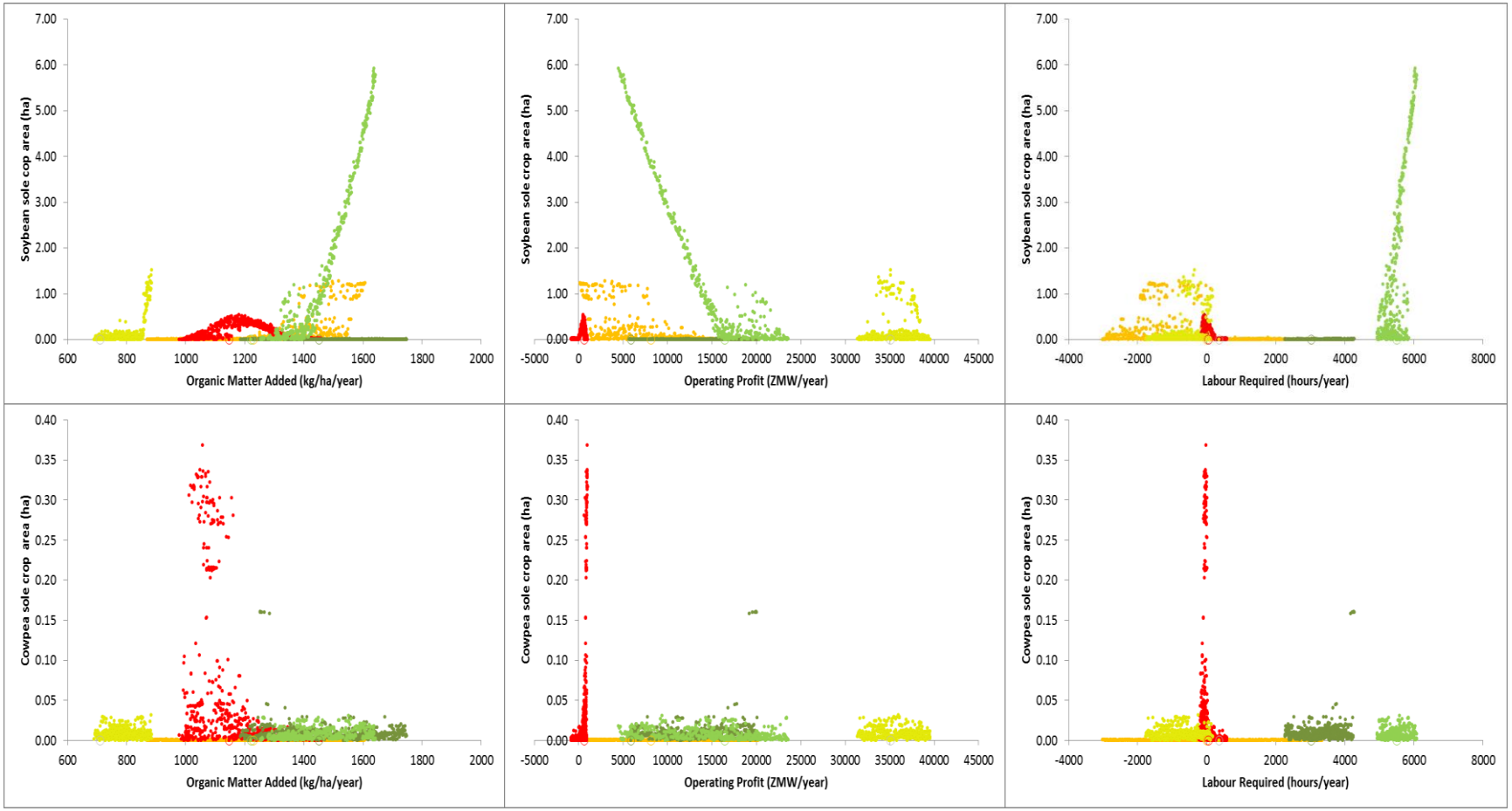

Figure 6.3. Differences in cultivated areas of soybean and cowpea crops in relation to changes in three farmer objectives, for five farm types in eastern Zambia (type-1: orange, type-2: red, type-3: dark green, type-4: light green, type-5: yellow). The points with a circle indicate the performance of the original farm configurations (all at zero).

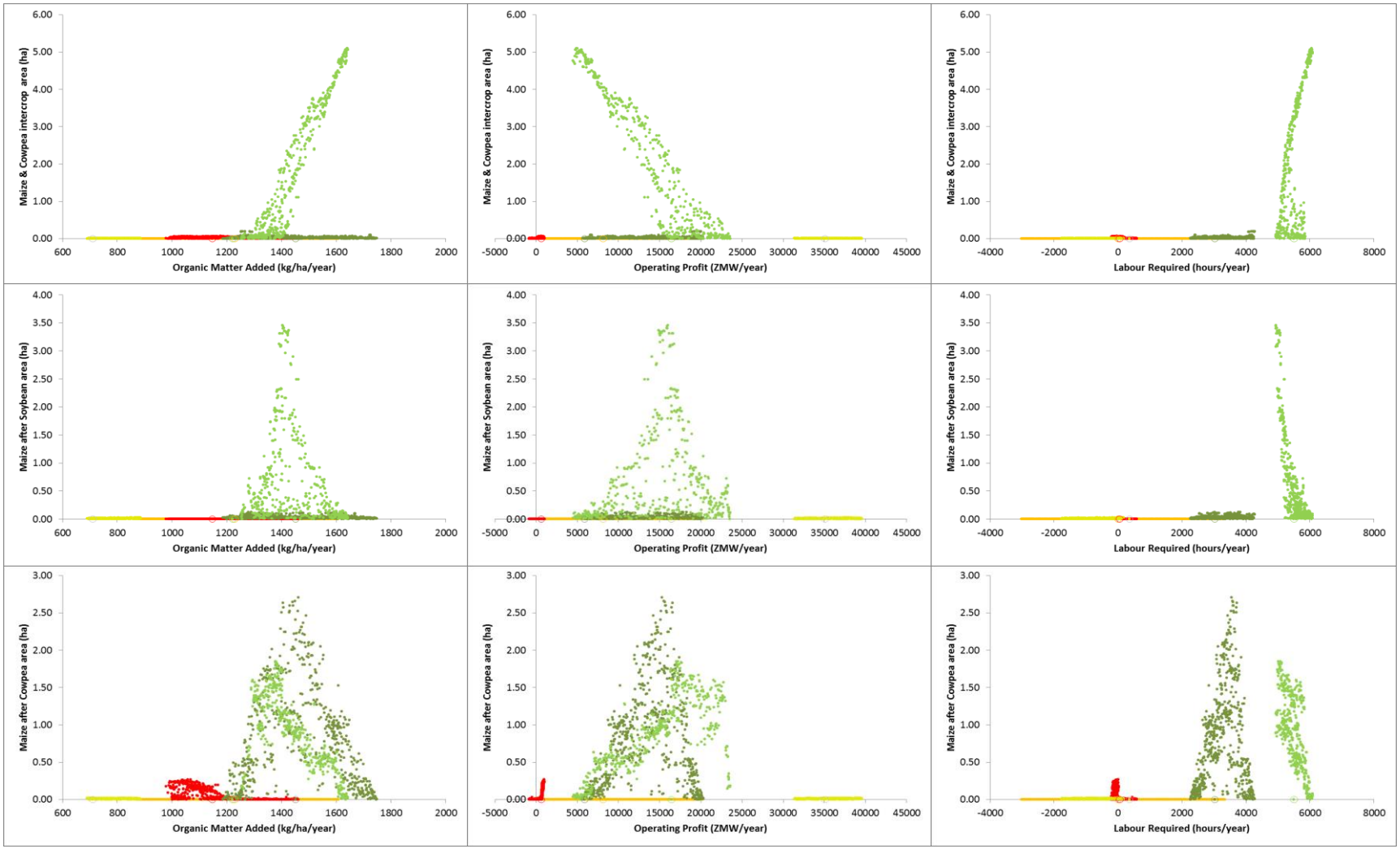

Figure 6.4. Differences in cultivated areas of maize-cowpea intercrop, maize after soybean and maize after cowpea crops in relation to changes in three farmer objectives, for five farm types in eastern Zambia (type-1: orange, type-2: red, type-3: dark green, type-4: light green, type-5: yellow). The points with a circle indicate the performance of the original farm configurations (all at zero).

Tradeoffs were identified between increasing operating profit and the other two objectives (increasing organic matter inputs and reducing labor required) for the five farm types, with only a few exceptions. In general, increasing the operating profit would require an increase in labor input (Figure 6.1c), and farm configurations with larger amounts organic matter inputs into the soil would have lower operating profit (Figure 6.1a). There was a synergy between increasing organic matter inputs and reducing the labor requirements (Figure 6.1b).

With further examination of Figure 6.1 (and Table 6.1) it can be seen that the type-5 farm currently has the highest operating profit and that the type-3 farm has the most organic matter added to the soil. The distance between the colored points and the current situation, horizontally or vertically, indicates the magnitude of the increase or decrease that can be reached in each objective that each point has. It can be seen that the type-2 farm (red) has relatively little room for increases in operating profit, yet has a larger range for improvement in organic matter. The result of this low range in operating profit probably stems from the fact that this farm's yields for maize are low (using low yielding local maize seeds and possibly poor management) and hence the predicted yields for entry point crops are consequently low as indicated in Tables 5.1 and 5.2. The reason that the type-5 farm (yellow) has a different shape to that of the other types is due to the fact that this farm with its large area of 23 ha has more room to maneuver to find different configurations and the trade-offs between operating profit and the other objectives were less pronounced than for the smaller farms.

For each point it is also possible to examine the corresponding changes in crop areas, input levels and allocation of products (so-called decision variables), and this has been presented in Figures 6.2, 6.3 and 6.4. In these figures each decision variable is plotted against each of the three objectives thus showing which changes in the farming systems are needed to reach a particular performance of the objective indicators. Only the most relevant decision variables related to the entry points have been presented.

In Figure 6.2, the upper three graphs show maize area in hectares and in the lower 3 graphs show the sum of the areas of other non-maize crops currently grown. It is thus visible that almost all points for all farm types have less area allocated to the current maize crop, showing that in order to meet the three objectives, it is feasible to exchange the current maize crop with either another current crop, or a new entry point crop. In the top three graphs it can be seen for the type-1 and type-5 farms that the model chose to replace their entire current maize crop area for another crop. The type-1 farm replaced maize with groundnuts or tobacco (fallow land was kept unchanged) while the type-5 farm replaced maize with cotton or sunflower, or left land fallow. All the points for these two types are at or near zero. The future changes to the model Farm DESIGN will include an analysis of the balance of nutrients supplied in the household diet by these crops such that tradeoffs can be seen between nutritional balances and income generation potential of cash crops like tobacco and cotton. By examining the points in the lower graphs in Figure 6.2, and those in Figures 6.3 and 6.4, it is possible to see which entry point crops or crop combinations could be allocated to achieve changes in the three objectives. As the farm area remains unchanged, a reduction in area of one crop will be reflected by an increase in

area of a crop that is more favorable in terms of achieving the objectives. The following sections present the findings of the exploration per farm type.

Type 1 farm (orange) is constrained by labor thus solutions that reduce the required labor compared to the current situation on the farm are most desirable. In the lower three graphs of Figure 6.2 almost all points show more area allocated to currently cultivated crops (other than maize). In Figure 6.3 it can be seen that there are options where some area has been allocated to the entry point sole soybean crop (up to a maximum of just over a hectare), showing improved organic matter added, operating profit, and less labor required. This is the only entry point crop that the model chose to allocate area to in the place of the current maize crop. This shows that if the farmer desires to reduce the labor required he should increase his area grown to soybeans. Although he is averse to growing soybeans (due to perceived increased labor requirements) (Table 4.7) they are beneficial in terms of increasing organic matter added, reducing labor but not increasing profit. There is a tradeoff between increasing the profit and increasing the labor when more land is allocated to tobacco or groundnuts.

Type-2 farm (red) is also constrained by labor. Thus this objective is perhaps the most important of the three for this farm type. In Figure 6.2 it can be seen that most points show the current maize area allocated to other crops, but also with most points allocated to other crops that are currently grown. In Figures 6.3 and 6.4 more area is allocated to sole cowpea than any other farm type, possibly indicating that this crop is most suitable for this type compared to other types. It can also be seen that the points have more magnitude to increase organic matter added than to increase operating profit. Roughly similar sized areas are added for sole soybean, and in Figure 6.4 it can be seen that some area is allocated to maize after cowpea and that the points for these three entry points show less labor required. As this farmer would be likely to adopt points with less labor required and because he seems averse to plant intercrops (as presented in Table 4.7), perhaps the combination of cowpeas in rotation with maize with the use of better maize varieties could be a suitable intervention with this type of farmer.

Type-3 farm (dark green) is less constrained by labor than type-1 and type-2 as they already hire in labor. In the upper graphs of Figure 6.2 there are both configurations with more area allocated to the current maize crop and less area allocated to the current maize crop. It is also shown that the options for more area allocated to the current maize crop also require more labor. Thus there is a tradeoff between labor required and profit as all configurations fulfil the objective to increase the operating profit. When examining Figures 6.3 and 6.4 it can be seen that the only entry point crop that has any significant increase in area allocated to it is maize after cowpea (up to a maximum of about 2.5 ha). Some very small areas of land are also allocated to the sole cowpea crop. Furthermore, most configurations that fulfil all three objectives have increased areas allocated to currently grown non-maize crops such as groundnuts and sunflowers. From Table 4.4 we can see that this farmer is willing to experiment but is also averse to planting intercrops, thus as with the type 2 farm, a rotation of cowpea with maize could possibly be the most suitable intervention for this farmer.

Type-4 farm (light green) has the objective to increase operating profit and reduce their labor requirement however increasing organic matter added may have lesser importance as they hire land to cultivate. In Figure 6.2 it can be seen that most configurations show less area allocated to the current maize crop. However those configurations with more area allocated to the current maize crop are also the same configurations with the least additional organic matter added, but also the greatest increases in operating profit. The options with the greatest increase in organic matter and the greatest deceases in operating profit are also the points with least area allocated to currently grown non-maize crops. The type-4 farm is the only type of farm whereby almost all entry point crops were allocated area by the model. The only entry point crop where hardly any land was allocated to was the sole cowpea crop. What is noticeable in Figures 6.3 and 6.4 is that the increases in area to sole soybean and maize and cowpea intercrop show a clear trade-off between increasing the organic matter added and decreasing the operating profit. As this type of farm is typified by high external off farm incomes, this trade-off may be of less importance. This farm type would possibly benefit from allocating some area to sole soybean, maize after soybean and to a lesser extent maize and cowpea intercropping, maize after cowpea or sole cowpea crops.

Type-5 farm (yellow) has little constraint with labor and profit and would place most importance on improving the soil quality with added organic matter. In figure 6.1 almost all configurations increase organic matter added and decrease labor required, yet not all increase operating profit. In Figure 6.2 it is shown that there are no configurations where the currently grown maize crop has any area allocated. In the lower graphs in Figure 6.2 it is visible that the area currently allocated to maize has in all configurations been allocated to currently grown non-maize crops (mainly sunflower and cotton). In Figures 6.3 and 6.4 it can be seen that the only entry point crop allocated any area is sole soybean. This area is also quite small, only up to a maximum of one hectare (of a total of 23 ha that are available). All other entry points have negligible or zero area allocated. The increases in area to sole soybean lead to increases in the organic matter added, the operating profit and the labor required, however this type of farmer probably would have the means to employ additional labor. In addition, this farmer had mentioned in the interview that he was becoming more aware of SIMLEZA's activities in the area and that he was willing to try to grow more legumes. This type of farmer would most likely be an adopter of new technologies, and sole legume crops like soybean would probably be the most suitable option.

In conclusion, considering the entry points explored with the model Farm DESIGN and the exploration with different farm types, we concluded from Section 5 that there was a gradient of increasing likelihood of adoption moving from type-1 farms through types-2, -3 and -4 to type-5 farms. Thereafter the exploration with the model Farm DESIGN showed which entry point crops would be most beneficial to which types taking into account the objectives to maximize operating profit and organic matter added and to minimize the labor requirements. Sole legume crops like soybeans were found beneficial to type-1, -4 and -5 farmers, whereas type-2 and -3 benefitted more from sole cowpea. For types -2, -3 and -4, including maize after the legume

crop was found to be beneficial. Only the type-4 farm was shown to have some benefit from an intercrop of maize and cowpea.

The next step in such an exploration is to return to the farmers to present these ideas to them to gain their viewpoint in how such an exploration can aid them in (re-)designing their cropping systems to achieve their objectives.

7. References

Alvarez, S., Paas, V., Descheemaeker, K. and Groot, J. 2014. Constructing typologies, a way to deal with farm diversity. General guideline for the Humidtropics project. Draft Version, May 2014.

Andersen, E., Elbersen, B., Godeschalk, F. and Verhoog, D., 2007. Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. Journal of environmental management, 82: 353-362.

Aregheore, E. M. 2014. Country Pasture/Forage Resource Profiles Zambia. *FAO*. Availabel online at: http://www.fao.org/ag/agp/AGPC/doc/Counprof/zambia/zambia.htm (Date of last access: 27.08.2014)

CFU, 2007. Map of agro-ecological zones, contained in the following document: Conservation Farming & Conservation Agriculture. Handbook for HOE Farmer s in Agro-Ecological. Regions I & II a - Flat Culture. 2007 Edition. Available online at: http://www.fsnnetwork.org/sites/default/files/conservation_agriculture__cf_handbook_for_hoe_farmers_zambia.pdf (Date of last access: 27.08.2014)

DFID, 2002. Map illustrating the population density in the different Zambian provinces. Available online at: http://www.fao.org/ag/agp/AGPC/doc/Counprof/zambia/figure3.htm (Date of last access: 27.08.2014)

FAO, 2004. The ethics of sustainable agricultural intensification. Rome: FAO ethics series, 3: 1-28.

Groot, J. C. J., Oomen, G. J. M., & Rossing, W. A. H. 2012. Multi-objective optimization and design of farming systems. *Agricultural Systems*, *110*, 63–77.

Hemminger, K. 2014. Towards integrated assessment of gender relations in faring systems analysis. Master Thesis supervised by Groot, J. and Bock, B. of WUR

Malapit, H. J., Sproule, K., Kovarik, C., Meinzen-dick, R., Quisumbing, A., Ramzan, F., … Alkire, S. 2014. *MEASURING PROGRESS TOWARD EMPOWERMENT WOMEN ' S EMPOWERMENT IN AGRICULTURE INDEX : BASELINE REPORT*. Washington DC.

MoA DAFF, 2011. Ministry of Agriculture. Department of Agriculture, Forestry and Fisheries. South Africa. Available online at: http://www.daff.gov.za/docs/brochures/prodguidecowpea.pdf (Date of last access: 27.08.2014)

Norman, D.W., and Gilbert, E. 1981. 'A general overview of farming systems research', in Shaner, W.W., Philipp, P.F., and Schmehl, W.R., eds, Readings in Farming Systems Research and Development, Consortium for International Development, Colorado State University, Boulder, CO, pp 18–34.

NSRL, 2014. Soybean Production. Panting, Growing and Harvesting Soybeans. Availabel online at: http://www.nsrl.uiuc.edu/aboutsoy/production02.html (Date of last access: 27.08.2014)

Ojiem, J.O., Ridder, N. de, Vanlauwe, B, Giller, K.E., 2006. Socio-ecological niche: A conceptual framework for integration of legumes in smallholder farming systems. International Journal of Agricultural Sustainability, 4: 79-93.

Pretty, J., Toulmin, C. and William, S., 2011. Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability, 9: 5-24. Royal Society, 2009. Reaping the benefits: Science and the sustainable intensification of global agriculture. London: Royal Society.

Siegel, P. B. 2008. *Profile of Zambia's Smallholders: Where and Who are the Potential Beneficiaries of Agricultural Commercialization? Africa Region Working Paper Series No. 113 June 2008*. Retrieved from http://www.worldbank.org/afr/wps/WPS113_Zambia_Smallholder.pdf

Simukoko, H., Marcotty, T., Phiri, I., Geysen, D., Vercruysse, J., & Van den Bossche, P. 2007. The comparative role of cattle, goats and pigs in the epidemiology of livestock trypanosomiasis on the plateau of eastern Zambia. *Veterinary Parasitology*, *147*(3-4), 231–8. doi:10.1016/j.vetpar.2007.04.005

The Montpellier Panel, 2013. Sustainable intensification: A new paradigm for African agriculture. London. Available online at: http://www.ag4impact.org (Date of last access 06.12.2013).

Tittonell, P., Muriuki, A., Shepherd, K.D., Mugendi, D., Kaizzi, K.C., Okeyo, J., Verchot, L., Coe, R. and Vanlauwe, B., 2009. The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa – a typology of smallholder farms. Agricultural systems, 103: 83-97.

Van de Brand, G., 2011. Towards increased adoption of grain legumes among Malawian farmers – Exploring opportunities and constraints through detailed farm characterization. Unpublished MSc thesis Plant Production Systems & Sustainable Development. Universiteit Utrecht, Wageningen UR.

Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia (SIMLEZA)

Baseline Survey Household Questionnaire for Eastern Zambia – 2011/2012

PART 0. INTERVIEW BACKGROUND

1. Respondent's name:.....

2. Mobile phone No…….…… 3. Landline phone no.....

4. Province..... 5. District .....

6. Block:…..……..……..... 7. Camp ……..……..…….....

8. Village.....

9. Interviewed by (enumerator's name):…..

10. Date of interview: Day:…..…….Month:.....Year:…..……

11. Checked by (supervisor's name) .....

12. Date checked: Day:……..…..……..Month:.....Year:…….……..

13. Entered by:…….……..….....

14. Date entered: Day:…….……..Month:.....Year:……..……

15. GPS readings of homestead: a) Waypoint ID ……b) Latitude ……

c) Longitude…….……; d) Altitude……

Household Identification Number.....

PART 1. FARMERS IDENTIFICATION AND VILLAGE CHARACTERISTICS

1. Religion of the household head (**Codes A**).....
2. Type of toilet used .....1. Flash toilet private; 2. Flash toilet shared; 3. VIP ventilated improved pit latrine private; 4. VIP ventilated improved pit latrine shared; 5. Ordinary pit latrine private; 6. Ordinary pit latrine shared; 7. No toilet/use open air
3. Main walling material of main residential house…….....…….....(**Codes B**)
4. Main roofing material of main residential house…….....……(**Codes C**)
5. Experience in growing maize (years)…….....…….....
6. Experience in growing legumes (years), Common bean..... Soybean.....….....Pigeonpea….....… Groundnut.....…..…Cowpea…….....
7. Taking into consideration ALL food sources (own food production + food purchase + help from different sources + food hunted from forest and lakes, etc), how would you assess your family's food consumption in the past 12 months? (**Codes D**) .....
8. Distance to the local (village) market from residence.....……..… minutes of walking time
9. What means of transport do you use most frequently to get to the local market? (**Codes E**) .....……
10. Distance to the nearest main (district) market from residence .....……..… minutes of walking time
11. Number of months the road to main (district) market is passable for vehicles in a year.....
12. Quality of road to the main market (district) (**Codes F**)…….....
13. Average one-way transport cost (per person) to the main market using a car (ZMK/person).....
14. Distance to the nearest seed dealer from residence .....minutes of walking time
15. Distance to the nearest fertilizer dealer from residence .....minutes of walking time
16. Distance to nearest herbicides/pesticides dealer from residence ……..minutes of walking time
17. Distance to the nearest farmer cooperative from residence …….....…minutes of walking time
18. Distance to the nearest farmers group/club from residence …….....…minutes of walking time
19. Distance to the nearest agricultural extension office from residence .....….minutes of walking time
20. Distance to the nearest health center from residence …….....…minutes of walking time
21. Main source of drinking water…….....(**Codes G**)
22. Do you boil water for drinking?.....(**Codes H**)
23. Do you treat water (chemical treatment) for drinking?.....**(Codes H**)
24. Distance to main water source for drinking from residence……..…minutes of walking time

---

Codes A: 1. No religion/atheist; 2. Christian; 3. Muslim; 4. Other, specify…….....……

Codes B: 1. Burned bricks; 2. Unburned bricks; 3. Mud bricks; 4. Concrete block; 5. Pole & mud; 6. Timber; 7.Stick and grass; 8. Iron sheet 9. Other, specify……..

Codes C: 1. Grass thatch; 2. Iron sheet; 3. Tiles; 4. Asbestos 5. Other, specify…….

Codes D: 1. Food shortage through the year, 2. Occasional food shortage, 3. No food shortage but no surplus, 4. Food surplus.

Codes E: 1. Walking; 2. Bicycle; 3. Tractor; 4. Vehicle; 5. Cart, 6. Other, specify……

Codes F: 1. Very poor; 2. Poor; 3. Average; 4. Good; 5. Very good;

Codes G: 1. Piped/tap; 2. Deep well protected and covered; 3. Deep well unprotected & uncovered; 4. Stream; 5. River; 6. Dams; 7. Ponds or floods; 8. Borehole Note: protected refers to water sources internally plastered and covered with a cap of wood, stone or concrete)

Codes H: 0. No; 1. Yes

Household Identification Number.....

PART 2: HOUSEHOLD COMPOSITION AND CHARACTERISTICS

Family code	Name of household member (start with respondent)	Sex **Codes A**	Age (years) [A]	Marital status **Codes B**	Education (years) **Codes C**	Relation to HH head **Codes D**	Occupation **Codes E**		Own farm labour contribution **Codes F**	For those under the age of 5 (see column 4)		
							Main	Secondary		Weight (kg)	Height (cm)	Had diarrhea in the last 1 year **Codes G**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
01												
02												
03												
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17												
18												
19												
20												

A/ For the under 5 year olds, ask month, date and year born and then compute the age yourself (in 3 decimal places).

Codes A	**Codes B**	**Codes C**	**Codes D**	**Codes E**	**Codes F**	**Codes G**
0. Female 1. Male	1. Married living with spouse/s 2. Married but spouse away 3. Divorced/separated 4. Widow/widower 5. Never married 6. Other, specify……	0. None/Illiterate 1. Adult education or 1 year of education * Give other education in years	1. Household head 2. Spouse 3. Son/daughter 4. Parent 5. Son/daughter in-law 6. Grand child 7. Other relative 8. Hired worker 9. Other, specify……	0. None 1. Farming (crop + livestock) 2. Salaried employment 3. Self-employed off-farm 4. Casual labourer on-farm 5. Casual labourer off-farm 6. School/college child 7. Non-school child 8. Herding 9. Household chores. 10.Other specify, ...	1. 100% 2. 75% 3. 50% 4. 25% 5. 10% 6. Not a worker	0. No 1. Yes

PART 3: SOCIAL CAPITAL AND NETWORKING

Have you and/or your spouse been member/s of formal and informal institutions in the last 3 years?.....1= Yes; 0=No. If **Yes** please ask the following table and if **No** go to Section B below.

Section A. Membership in formal and informal institutions <u>in the last 3 years</u> (husband and wife/wives only. One group membership per row.)

Family code	Type of group the husband/wife is/was a member of: (**codes A**)	Three most important group functions: **(codes B)**			Year joined (YYYY)	Role in the group **(codes C)**	Still a member now? **(codes D)**	If No in column 8, reason/s for leaving the group (**codes E**), Rank 3		
		1st	2nd	3rd				1st	2nd	3rd
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Codes A
1. Input supply/farmer coops/union
2. Crop/seed producer and marketing group/coops
3. Local administration
4. Farmers' Association
5. Women's Association
6. Youth Association
7. Church/mosque association/congregation
8. Saving and credit group
9. Funeral association
10. Government team
11. Water User's Association
12. Other, specify……

Codes B
1. Produce marketing
2. Input access/marketing
3. Seed production
4. Farmer research group
5. Savings and credit
6. Funeral group
7. Tree planting and nurseries
8. Soil & water conservation
9. Church group /congregation
10. Input credit
11. Other, specify……

Codes C
1. Official
2. Ex-official
3. Ordinary member

Codes D
0. No
1. Yes

Codes E
1. Left because organization was not useful/profitable
2. Left because of poor management
3. Unable to pay annual subscription fee
4. Group ceased to exist
5. Other, specify……

Section B. Social networks

1. Number of years the respondent has been living in this village .....
2. Number of people that you can rely on for critical support in times of need <u>within this village</u>

   Relatives .....Non-Relatives .....
3. Number of people you can rely on for support in times of need <u>outside this village</u>

   Relatives ……..…..……..; Non-Relatives .....
4. Are any of your friends or relatives in leadership positions in formal or informal institutions <u>within and outside this village</u> ?..... **Codes:** 0. No 1. Yes
5. Number of grain traders that you know in this village who could buy your grain.....
6. Number of grain traders that you know outside this village who could buy your grain…….…….
7. Generally speaking, most grain traders can be trusted.....(**Codes A** below)
8. If answer in Question 7 above is 1, 2 or 3, then which types of grain traders do you mistrust more.....?

   Codes: 1.Wholesellers; 2. Retailers; 3. Assemblers; 4. Brokers; 5. Others .....
9. And why do you mistrust these types of grain traders more?.....

   .....
10. Do you think you can rely on government support (subsidies, food aid etc) if your crop fails?.....

    Codes: 1.Yes; 0. No
11. You are confident of the skills of government officials including extension workers to do their job……..…… (**Codes A** below)

    Codes A: 1. Strongly disagree; 2. Disagree; 3. Slightly disagree; 4. Neither agree or disagree; 5. Slightly agree; 6. Agree; 7. Strongly agree

PART 4. HOUSEHOLD ASSETS

Section A: Production equipment and major household furniture

Asset	Number (if no equipment put zero)	Original purchase price (ZMK) (if more than one item reported in column 2 take average price)	If you would sell [….] how much would you receive from the sale? (ZMK) (if more than one item reported in column 2 take average price)
1	**2**	**3**	**4**
1. Horse/mule cart			
2. Donkey/ox cart			
3. Horse/Mule saddle			
4. Push cart			
5. Ox-plough			
6. Sickle			
7. Pick Axe			
8. Axe			
9. Hoe/Jembe			
10. Knapsack sprayer			
11. Water carrier made of canvass/skin/inner tire tube			
12. Stone grain mill			
13. Motorized grain mill			
14. Water mill			
15. Mechanical water pump (hand, foot, "*treadle pump")*			
16. Motorized water pump (diesel)			
17. Spade or shovel			
18. Radio, cassette or CD player			
19. Cell phone			
20. Improved charcoal/wood stove			
21. Kerosene stove			
22. Bicycle			
23. Motorbike			
24. Cars			
25. Picks-ups			
26. Trucks (lorry)			
27. Tractors			
28. Trailers			

Section A: Production equipments and major household furniture (cont'd)

Asset	Number (if no equipment put zero)	Original purchase price (ZMK) (if more than two items reported in column 2 take average price)	If you would sell [….] how much would you receive from the sale? (ZMK) (if more than two items reported in column 2 take average price)
1	2	3	4
29. Jewellery: gold, silver, wristwatches			
30. Wooden box			
31 Metal box			
32. Leather bed			
33. Wooden bed			
34. Metal bed			
35. TV			
36. Chairs			
37. Table			
38. Gun			
39. Grass roofed house			
40. Corrugated iron sheet house			
41.Fish pond			
42. Sofa			
43. Panga knife			
44. Other,specify			
45. Other , specify			

Section B: Land holding (hectares) during the 2010/11 cropping year (last cropping year)-HERE SKETCH FIELDS

Land category	**Main season (Nov/Dec 2010/11)**	
	Cultivated (vegetables + annual + permanent crops (e.g., coffee, mangoes, Banana)	Uncultivated (e.g. grazing, fallow, homestead etc)
1	2	3
1. Own land used (A)		
2. Rented in land (B)		
3. Rented out land (C)		
4. Borrowed in land (D)		
5. Borrowed out land (E)		
6. Total owned land (A+C+E)		
7. Total operated land (A+B+D)		
8. Bought land during 2010/11 season		
9. Sold land during 2010/11 season		

Household Identification Number.....

PART 5. IMPROVED CROP* VARIETY KNOWLEDGE AND ADOPTION

Section A. Crop variety knowledge, sources of information and seed, adoption and disadoption

Improved crop varieties aware/heard of **Codes from Annex 2**	If you have a local name for this variety, what is it? If no local name, put 0	Year variety known or heard of **YYYY**	Sources of variety information **Codes A,** Rank 3	Ever planted ? **Codes B**	If **NO in Column 5,** Why? **Codes C** Rank 3	If **YES in column 5,** year first planted **YYYY**	**If Yes in column 5**				Planted variety in 2010/11 **Codes B**	Will plant variety in future **Codes B**	If No in Column 13, why not, **Codes C Rank 3**
							First seed						
							Main source of first seed **Codes D**	Amou nt **kg**	Means of acquiring first seed **Codes E, Rank 3**	No. of seasons variety has been planted			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**

***Crop of interest:** Maize, Common beans, Pigeonpea, Groundnut, Soybean, Cowpea

Codes A
0. None other
1. Government extension
2. Farmer Coop/Union
3. Farmer group
4. NGO/CBO
5. Research centre (trials/demos/ days)
6. Seed/grain stockist
7. Relative/ Neighbour
8. Radio/newspaper/TV
9.Other, Specify…....

Codes B
0. No
1. Yes

Codes C
0. None other
1. Seed not available
2. Lack of cash/credit to buy seed
3.Susceptible to diseases/pests
4. Poor taste
5. Low yielding variety
6. Low grain prices
7. No market
8. Theft during green stage
9. Lack of enough land
10. Requires high skills
11.Content with current
12. Other, specify…….

Codes D
1. On-farm trials
2. Extension demo fields
3. Farmer groups/Coops
4. Local seed producers
5. Seed retailers
6. Private seed suppliers
7.FISP
8.Club/association
9. Farmer to farmer seed exchange
10. Provided free by NGOs/govt
11. Other (specify)……

Codes E
0. None other
1. Gift/free
2. Borrowed seed
3. Bought with cash
4. Payment in kind
5. Exchange with other seed
6. Subsidy
7. Advance pay from coop
8. Other, specify……

Section A. Crop variety knowledge, sources of information and seed, adoption and disadoption **.....continued**

Improved crop varieties aware/heard of **Codes from Annex 2**	If you have a local name for this variety, what is it? If no local name, put 0	Year variety known or heard of **YYYY**	Sources of variety information **Codes A,** Rank 3	Ever planted ? **Codes B**	If **NO in Column 5,** Why? **Codes C** Rank 3	If **YES in column 5,** year first planted **YYYY**	**If Yes in column 5**				Planted variety in 2010/11 **Codes B**	Will plant variety in future **Codes B**	If No in Column 13, why not, **Codes C Rank 3**
							First seed						
							Main source of first seed **Codes D**	Amou nt **kg**	Means of acquiring first seed **Codes E, Rank 3**	No. of seasons variety has been planted			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**

***Crop of interest:** Maize, Common beans, Pigeonpea, Groundnut, Soybean, Cowpea

Codes A
0. None other
1. Government extension
2. Farmer Coop/Union
3. Farmer group
4. NGO/CBO
5. Research centre (trials/demos/ days)
6. Seed/grain stockist
7. Relative/ Neighbour
8. Radio/newspaper/TV
9.Other, Specify…....

Codes B
0. No
1. Yes

Codes C
0. None other
1. Seed not available
2. Lack of cash/credit to buy seed
3.Susceptible to diseases/pests
4. Poor taste
5. Low yielding variety
6. Low grain prices
7. No market
8. Theft during green stage
9. Lack of enough land
10. Requires high skills
11.Content with current
12. Other, specify…….

Codes D
1. On-farm trials
2. Extension demo fields
3. Farmer groups/Coops
4. Local seed producers
5. Seed retailers
6. Private seed suppliers
7.FISP
8.Club/association
9. Farmer to farmer seed exchange
10. Provided free by NGOs/govt
11. Other (specify)……

Codes E
0. None other
1. Gift/free
2. Borrowed seed
3. Bought with cash
4. Payment in kind
5. Exchange with other seed
6. Subsidy
7. Advance pay from coop
8. Other, specify……

Section B: Maize variety characteristics grown during 2010/11 and/or in the past [main local variety first]

Characteristics	Maize varieties (main local variety first column, Codes in Annex 2)-use Codes A below									
	1……	2 …...	3……	4……	5……	6……	7……	8……	9……	10……
1	2	3	4	5	6	7	8	9	10	11
Variety type according to farmer (1=OPV; 2=Hybrid; 3=Don't know)										
Agronomic										
1. Grain yield										
2. Stover (crop residue) yield										
3. Palatability of Stover to livestock										
4. Drought tolerance										
5. Water-logging tolerance										
6. Disease tolerance										
7. Insect pest tolerance										
8. Early maturity										
9. Uniformity in maturity										
10. Grain size										
11. Cob Size										
12. Labour input requirement										
13. Other inputs requirement										
Market and economics										
14. Marketability (demand)										
15. Grain colour										
16. Output (grain) price										
Cooking & utilization										
17. Storability										
18. Cooking time (boiling grain/cob)										
19. Taste										
20. Nutritional value										
21. Overall variety score										

Codes A 1. Very poor, 2. Poor, 3. Average 4. Good, 5. Very Good

Section C: Soya bean variety characteristics grown during 2010/11 and/or in the past [main local variety first]

Characteristics	Soya bean varieties (main local variety first column, Codes in Annex 2)- use Codes A above									
	1…..	2……	3……	4……	5……	6……	7……	8……	9……	10……
1	2	3	4	5	6	7	8	9	10	11
Agronomic										
1. Grain yield										
2. Stover (crop residue) yield										
3. Palatability of Stover to livestock										
4. Drought tolerance										
5. Water-logging tolerance										
6. Disease tolerance										
7. Pest tolerance										
8. Early maturity										
9. Uniformity in maturity										
10. Grain size										
11. Labour input requirement										
12. Other inputs requirement										
Market and economics										
13. Marketability (demand)										
14. Grain colour										
15. Output (grain) price										
Cooking & utilization										
16. Storability										
17. Cooking time										
18. Taste										
19. Overall variety score										

Section D: Groundnut variety characteristics grown during 2010/11 and in the past [main local variety first]

Characteristics	**Groundnut varieties (main local variety first column, Codes in Annex 2)-use Codes A below**									
	1…..	**2……**	**3……**	**4……**	**5……**	**6……**	**7……**	**8……**	**9……**	**10……**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Agronomic										
1. Grain yield										
2. Stover (crop residue) yield										
3. Palatability of Stover to livestock										
4. Drought tolerance										
5. Water-logging tolerance										
6. Disease tolerance										
7. Pest tolerance										
8. Early maturity										
9. Uniformity in maturity										
10. Grain size										
11. Labour input requirement										
12. Other inputs requirement										
Market and economics										
13. Marketability (demand)										
14. Grain colour										
15. Output (grain) price										
Cooking & utilization										
16. Storability										
17. Cooking time										
18. Taste										
19. Overall variety score										

Codes A 1. Very poor, 2. Poor, 3.Average, 4. Good, 5. Very Good

Section E: Common bean variety characteristics grown during 2010/11 and in the past [main local variety first]

Characteristics	**Common bean varieties (main local variety first column, Codes in Annex 2)- use Codes A below**									
	1…..	**2……**	**3……**	**4……**	**5……**	**6……**	**7……**	**8……**	**9……**	**10……**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Agronomic										
1. Grain yield										
2. Stover (crop residue) yield										
3. Palatability of Stover to livestock										
4. Drought tolerance										
5. Water-logging tolerance										
6. Disease tolerance										
7. Pest tolerance										
8. Early maturity										
9. Uniformity in maturity										
10. Grain size										
11. Labour input requirement										
12. Other inputs requirement										
Market and economics										
13. Marketability (demand)										
14. Grain colour										
15. Output (grain) price										
Cooking & utilization										
16. Storability										
17. Cooking time										
18. Taste										
19. Overall variety score										

Codes A 1. Very poor, 2. Poor, 3.Average, 4. Good, 5. Very Good

Section F: Cowpea variety characteristics grown during 2010/11 and in the past [main local variety first]

Characteristics	**Cowpea varieties (main local variety first column, Codes in Annex 2)- use Codes A below**									
	1…..	**2……**	**3……**	**4……**	**5……**	**6……**	**7……**	**8……**	**9……**	**10……**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Agronomic										
1. Grain yield										
2. Stover (crop residue) yield										
3. Palatability of Stover to livestock										
4. Drought tolerance										
5. Water-logging tolerance										
6. Disease tolerance										
7. Pest tolerance										
8. Early maturity										
9. Uniformity in maturity										
10. Grain size										
11. Labour input requirement										
12. Other inputs requirement										
Market and economics										
13. Marketability (demand)										
14. Grain colour										
15. Output (grain) price										
Cooking & utilization										
16. Storability										
17. Cooking time										
18. Taste										
19. Overall variety score										

Codes A 1. Very poor, 2. Poor, 3.Average, 4. Good, 5. Very Good

Household Identification Number.....

Section G: Main sources and quantity of seed for Maize, Common beans, Pigeonpea, Groundnut, Soybean, Cowpea and other major legumes grown last cropping year (2010/11): <u>One variety per row</u>

Crop **(Use codes in Annex 1)**	Crop variety **(Use codes in Annex 2)**	Total amount of seed **(kg)**	Quantity of seed and sources (this data should match with P.11)							
			Source 1		***Source 2***		***Source 3***		***Source 4***	
			Codes A below	***Amount (kg)***	***Codes A below***	***Amount (kg)***	***Codes A below***	***Amount (kg)***	***Codes A below***	***Amount (kg)***
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Codes A

1. Own saved seed
2. Stockists/agro dealers
3. Seed companies (e.g. ZAMSEED, PANNAR e.t.c)
4. Gift from family/neighbor
5. FISP/subsidy
6. Farmer groups/association/cooperatives
7. Farmer to farmer seed exchange
8. Local market (open market)
9. On-farm trials/ extension demo fields
10. Provided free by NGOs/govt
11. Other (specify).....

Household Identification Number……

PART 6. CROP PRODUCTION FOR <u>ALL CROPS</u> (cereals annual + perennial + vegetables) GROWN BY THE HOUSEHOLD DURING 2010/11 crop calendar

Section A. Characteristics, investment and input use

Definitions: A field is a piece of land physically separated from others; a plot is a subunit of a field. If more than one crop is grown on a field (that is, on different plots), repeat the code in next row and use plot code. If the plot is intercropped, use same row and separate the different intercrops by comma e,g.,(1,2) for maize and beans intercrop. Consider only 3 main intercrops if more than 3 crops on a plot.

Serial number	Field code (start with one next to residence)	Field location name (as called by farmer)	Plot code	Plot size (hectares)	Intercrop **(0=No; 1=Yes)**	Crop(s) grown **(Use Annex 1 codes)**	Crop variety **(Use Annex 2 codes)**	Percent of area under each intercrop (e.g. 50,50)	Field distance from residence **(walking minutes)**	Plot ownership **Codes A**	Plot manager **Codes B**	Soil fertility **Codes C**	Soil slope **Codes D**	Soil depth **Codes E**	Soil type/colour **Codes F**	Soil & water conservation method **Rank 3 Codes G**	Crop residue left on plot **1=Yes; 0=No**	Purely irrigated **(0=No; 1=Yes)**	Zero or minimum tillage on the plot? **(0= No; 1= Yes)**	
																			Ever practiced before	Practiced 2010/11
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**

Codes A		**Codes B**	**Codes C**	**Codes D**	**Codes E**	**Codes F**		**Codes G**		
1. Owned	4. Borrowed in	0. Women	1. Good	1. Gently slope (flat)	1. Shallow	1. Black	4.Grey	0. None	3. Grass strips	6.Minimum till
2. Rented in	5.Borrowed out	1. Men	2. Medium	2. Medium slope	2. Medium	2. Brown	5. Other,	1. Terraces	4. Trees on	7.Soil bunds
3. Rented out	6. Other, specify….	2. Both equally	3. Poor	3. Steep slope	3. Deep	3. Red	specify…	2. Mulching	boundaries	8.Stone bunds
									5. No tillage	9. Box ridges
										10.Other, specify…

Household Identification Number……

Section B: Input use for <u>all crops</u> grown by the household during 2010/11

(<u>Serial number, field code, plot code, crop(s) and variety grown</u> in this Section should be in <u>exactly the same order as in Section A</u> above)

Serial number	Field code	Plot code	Crop(s) grown **(As in Section A above)**	Crop variety **(As in Section A above)**	Crop rotation **(0=No; 1=Yes)**	Previous season **<u>main</u>** crop grown **(Annex 1 codes)**	Fertilizer (If not used, put Zero)					Seed use (if intercropped, <u>separate by comma</u>)					Manure (dry equivalent)			Herbicides used	
							Basal fertilizer		Top dressing fertilizer- urea etc		<u>Main</u> method of payment for fertilizer used (**Codes A**)	Non-bought seed (own saved, farmer to farmer exchange, etc (**kg or Nos**)	No. of seasons own saved <u>seed recycled</u>	Bought seed (including using credit & voucher)		<u>Main</u> method of payment for seed used (**Codes A**)	own	Bought		**Amount (Litres/kg)**	Total cost **(ZMK)**
							Amount **(Kg)**	Total cost **(ZMK)**	Amount **(Kg)**	Total cost **(ZMK)**				Amount **(kg)**	Total cost **(ZMK)**		Amount **(kg)**	Amount **(kg)**	Total cost **(ZMK)**		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Codes A 1.Own cash 2. government subsidy 3. donor supported vouchers 5. Money got as gift from relative & non-relatives 6. Credit from savings and credit organizations	7. Credit form bank 8. Credit money lender 9. Credit from relative/neighbour/friend 10. Credit micro-finance 11. Credit from NGO **12. Own saved seed**	13. Other, specify ……..…

Household Identification Number……

Section C: Input use and crop harvested

(Serial number, field code, plot code, crop(s) and variety grown in this Section should be in exactly the same order as in Section A and Section B above)

Serial number	Field code	Plot code	Crop(s) grown	Pesticides used		Oxen-days or person-days (for hand hoes)		Total labour (family and hired) used in person-days Intercrops: record harvesting and threshing/shelling separately (by comma)									Cost of oxen/tractor hired **(ZMK)**	Cost of hired labour **(ZMK)**	Stress incidence on field **Codes A**	Total harvested per plot Intercrops: separate by comma	
								Land preparation & planting		Weed control			Harvesting		Threshing or shelling					Fresh or green **(kg)**	Dry **(kg)**
				Amount **(Litres/kg)**	Total cost **(ZMK)**	Plowing Freq	Total Plowing oxen days	Male	Female	Weeding freq	Male	Female	Male	Female	Male	Female					
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**

Codes A: 0. No stress; 1. Insect pests; 2. Diseases; 3. Water logging; 4. Drought; 5. Frost; 6. Hailstorm; 7. Animal trampling; 8. Other, specify……

Household Identification Number……

Section D: Utilization of crop produced and household food security

Different from Sections A, B and C above: i.e. record one row per crop (e.g. add production from all maize fields together)

Crop **(From Section C above)**	Form **Codes A**	Carry over stock from 2009/10 harvest **(kg)**	Production of 2010/11 (last columns of Section C) **(kg)**	Total available stock for 2010/11 use **(kg)**	From the total available stock (**column 5**)…					Amount left in store before 2011/12 harvest **(kg)**
					Quantity sold **(kg)**	In-kind payments (labour, land & others) paid during 2010/11 cropping year **(kg)**	Seed used during 2011/12 cropping year **(kg)**	Gift, tithe, donations given out during 2010/11 cropping year **(kg)**	Consumption during 2010/11 cropping year **(kg)**	
1	**2**	**3**	**4**	**5=3+4**	**6**	**7**	**8**	**9**	**10**	**11=5-6-7-8-9-10**

Codes A: 1. Fresh/green; 2. Dry

Household Identification Number……

Section E: Marketing of crops

Different from Sections A, B, C and D: i.e. record one row per sale (different months, different buyers), per crop

Crop **(From Column 1 of Section D above)**	Form **(From Column 2 of Section D above)**	Market type **Codes A**	Month sold **Codes B**	Quantity sold **(kg)** (sum should be equal to Column 6 of Section D)	Who sold **Codes C**	Price (ZMK/kg)	Buyer **Codes D**	Period to payment after selling, **(weeks)** (if immediate write zero)	Relation to buyer **Codes E**	Quality **Codes F**	Sales tax or charges **(ZMK)**	Time taken to sell crop **(minutes)**	Time taken to get to the market **(minutes)**	Mode of transport **Codes G**	Actual transport cost **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**

Codes A	**Codes B**		**Codes C**	**Codes D**		**Codes E**	**Codes F**	**Codes G**
1. Farmgate	1. January	7. July	0. Female	1. Farmer group/union /coop/club	6. Urban grain trader/wholesaler	1. No relation but not a long time buyer	1. Below average	1. Bicycle
2. Village market	2. February	8. August	1. Male	2. Consumer or other farmer	7. Exporter	2. No relation but a long term buyer	2. Fair and Average	2. Hired vehicle
3. Main/district market	3. March	9. September	2. Both	3. Rural assembler	8. Millers	3. Relative	3. Above average	3. Public transport
	4. April	10. October		4. Broker/middlemen	9. FRA	4. Friend		4. Donkey
	5. May	11. November		5. Rural grain trader/wholesaler	10. Other, specify……..	5. Money lender		5. Oxen/horse cart
	6. June	12. December				6. Other, specify……		6. Back/head load
								7. Other, specify……...

Section F: Percent (%) utilization of crop residues produced during 2010/11 season
Same order of crops as section D above. Note that percentages need to add up to 100% for every row.

Crop (same order as in section D above)	Burnt in the field (%)	Used as firewood (%)	Left on land for soil fertility (%)	Feed for livestock (%)	Used for construction (%)	Sold (%)	Other uses (%)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

PART 7: LIVESTOCK PRODUCTION AND MARKETING

Section A: Livestock production activities during 2010/11 cropping year

Livestock type	Number of livestock at end of 2010/11 cropping season (including bought ones)	If you would sell […], how much would you receive from the sale? **(ZMK/unit)** (if more than one livestock take average price)	Average **total days** milked per animal	Average daily milk yield per animal **(liters)**	Total milk production **(liters)** & honey production **(kg)**
1	**2**	**3**	**4**	**5**	**6=2*4*5**
Cattle					
1. Indigenous milking cows					
2. Cross-bred milking cows					
3.Exotic milking cows					
4. Non milking cows (mature)					
5. Trained oxen for ploughing					
6. Bulls					
7. Heifers					
8. Calves					
9. Goats					
10. Sheep					
11.Donkeys					
12.. Horses					
13. Fish in ponds					
14. Mature chicken					
15. Local Bee hives					
16.Modern Bee hives					
17.Pigs, mature					
18.Pigs, young					
19. Guinea fowls					
20. Ducks					
21. Rabbits					
22. Turkeys					
23. Other……					
24. Other……					
25. Other……					
26. Other……					
27. Other……					
28. Other……					
29. Other……					
30.Other					

Section B: Livestock and livestock products selling and buying activities last year

Livestock/products	Selling				Buying			
	Quantity sold	Unit	Who sold **Codes:** 0 = Women 1 = Men 2= Both	Average per unit price **(ZMK/unit)**	Quantity bought	Unit	Who Bought **Codes:** 0 = Women 1 = Men 2=Both	Average per unit price **(ZMK/unit)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Indigenous milking cows								
2. Crossbred milking cows								
3.Exotic milking cows								
4. Non milking cows (mature)								
5. Trained oxen for ploughing								
6. Bulls								
7. Heifers								
8. Calves								
9. Mature milking goats								
10. Other mature female goats								
11. Mature male goats								
12. Young female goats								
13.Young male goats								
14. Mature female sheep								
15. Mature male sheep								
16. Young female sheep								
17.Young male sheep								
18. Mature trained donkeys								
19. Young donkeys								
20. Horse								
21. Mules								
22. Mature chicken								
23. Local Bee hives								
24.Modern Bee hives								
25.Pigs, mature								
26.Pigs, young								
27.Turkeys, mature								
28.Guinea fowls, mature								
29.Ducks, mature								
30.Rabbit, mature								
31. Other								
32. Other								
33. Other								
Animal products								
34.Milk (check sale if production recorded)								
35.Eggs								
36.Butter								
37.Beef								
38.Mutton								
39.Yoghurt								
40.Honey								
41Fish								
42.Hide								
43.Skin								
44.Manure								
45. Sour milk								
46. Other.....								

PART 8: TRANSFER AND OTHER SOURCES OF INCOME LAST YEAR

Who earned/received? **Use family code from Part 2: Household composition and characteristics**	Sources of income **Use Codes A**	No. of units worked/ received	Unit (e.g. month, week, day, year, kg, no.)	Amount per unit (Cash & in-kind)		Total income (cash & in-kind)		Total income **(ZMK)**
				Cash **(ZMK)**	Payment in kind **Cash equivalent**	Cash **(ZMK)**	Payment in kind **Cash equivalent**	
1	**2**	**3**	**4**	**5**	**6**	**7= 3x5**	**8=3x6**	**9= 7+8**

Codes A

1. Rented/sharecropped out land
2. Rented out oxen for ploughing
3. Salaried employment
4. Farm labour wages
5. Non-farm labour wages
6. Non-farm agribusiness NET income (e.g. grain milling/trading)
7. Other business NET income (shops, trade, tailor, sales of beverages etc)
8. Pension income
9. Drought/flood relief
10. Safety net or food for work
11. Remittances (sent from non-resident family and relatives living elsewhere)
12. Marriage Gifts
13. Sales of firewood/charcoal
14. Brick making
15. Poles from own and communal forests
16. Sale of crop residues
17. Quarrying stones
18. Rental property (other than land and oxen)
19. Interest from deposits
20. Social cash transfer
21. Other, specify ……..……...

Questionnaire No…… ***(Supervisor to fill)***

PART 9. HOUSEHOLD EXPENDITURE

(Here, wife and/or the person involved in purchases should be the principal respondent/s)

Section A: Food consumption

No.	Item	**Unit** (e.g. kg, litter, packet, bundle, number)	**Bought in the last 12 months**				
			Frequency of buying (e.g., one time per year, two times per year, etc)	Average quantity each time (e.g. 2 kg; 4 bundles etc)	Total quantity per year	Average price per unit **(ZMK)**	Total cost of purchased **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6x7**
	Staple foods						
1	Maize (dry)						
2	maize(flour)						
3	Maize (green)						
4	Wheat (flour)						
5	Wheat (dry)						
6	Barley						
7	Rice						
8	Sorghum						
9	Millet						
10	Cassava						
11	Potatoes						
12	Beans dry						
13	Beans fresh						
14	Cowpea fresh grain						
15	Cowpea dry grain						
16	Cowpea leaves						
17	Groundnut fresh						
18	Groundnut dry						
19	Soybean						
20	Pigeonpea fresh						
21	Pigeonpea dry						
22	Greengram (*Mphodza)*						
23	Bananas						
24	Sweet potatoes						
25	Other, specify.....						
	Beverages and drinks						
26	Tea (leaves)						
27	Tea (liquid)						
28	Coffee (powder)						
29	Coffee (liquid)						
30	Soft drinks						
31	Juices						
32	Local beer						
33	Bottled/clear beer						
34	Wine						
35	Drinking water						
36	Coffee beans						
37	Opaque beer (*chibuku*)						

Section A: Food consumption (cont'd)

No.	Item	Unit (e.g. kg, litter, packet, bundle, number)	Bought in the last 12 months				
			Frequency of buying (e.g., one time per year, two times per year, etc)	Average quantity each time	Total quantity per year	Average price per unit **(ZMK)**	Total cost of purchased **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6x7**
	Fruits						
38	Oranges						
39	Mangoes						
40	Pawpaws						
41	Pineapple						
42	Bananas (ripe)						
43	Apple						
44	Guava						
45	Coconut						
46	Sugar cane						
47	Other.						
	Meat &other products						
48	Beef						
49	Goat meat						
50	Sheep meat						
51	Pig meat						
52	Chicken						
53	Turkey						
54	Ducks						
55	Bush meat						
56	Fish						
57	Eggs						
58	Milk						
59	Cheese/Ghee						
60	Butter						
61	Yoghurt						
62	Honey						
63	Other.						
	Vegetables						
64	Tomatoes						
65	Onions						
66	Cabbage						
67	Spinach						
68	Kale						
69	Carrot						
70	Okra						
71	Pumpkin						
72	Egg plant						
73	Cucumber						
74	Pepper						
75	Garlic						

Section A: Food consumption (contd)

No.	Item	Bought in the last 12 months					
		Unit (e.g. kg, litter, packet, bundle, number)	Frequency of buying (e.g., one time per year, two times per year, etc)	Average quantity each time	Total quantity per year	Average price per unit **(ZMK)**	Total cost of purchased **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6x7**
	Beverages and drinks (cont'd)						
76	Water for livestock						
77	Water for other uses						
78	Other.						
79							
	Fats, oils, sweeteners, snacks and others						
80	Cooking fat						
81	Margarine						
82	Groundnut oil						
83	Coconut oil						
84	Bread						
85	Biscuits						
86	Popcorn						
87	Cashew nuts						
88	Sugar						
89	Salt						
90	Chocolate						
91	Curry						
92	Ginger						
93	Macadamia nuts						
94							
	Meals eaten away from home (specify)						
95							
96							
97							
98							
99							
100							

Questionnaire No…… ***(Supervisor to fill)***

Section B: Expenditure on non-food items in the last 12 months

No.	Expense Item	Unit (e.g. kg, litter, packet, bundle, number)	Frequency of purchase (e.g., one time per year, two times per year, etc)	Average quantity each time	Total quantity per year	Average per unit price **(ZMK)**	Total cost of purchase **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6x7**
1	Clothing						
2	Shoes						
3	Blankets						
4	Bed sheets						
5	Soap/washing products						
6	Electricity						
7	Fuel wood						
8	Charcoal						
9	Kerosene						
10	Batteries						
11	School fees						
12	School books and supplies						
13	Health care (medicare, treatment)						
14	Grain milling						
15	Land tax						
16	Church contributions						
17	Dowry						
18	Contributions to farmer associations/cooperatives						
19	Contributions to other associations/cooperatives						
20	Other membership fees						
21	Funeral group payments						
22	House building/construction						
23	Contribution to sports						
24	Guard/security						
25	Newspapers, magazines etc						
26	Travel expenses						
27	Mobile phone air time (voucher)						
28	Radio/TV service charge						
29	Payment for extension advisory services						
30	Pay for improvement of communal services (roads etc)						
31	Kitchen utensils						
32	Personal care (toothpaste, nail etc)						
33	Furniture (tables, chairs, beds etc)						
34	Home repairs						
35	Purchase of cars						
36	Purchase of bicycle, motorcycle etc						
37	Repairs for vehicles, bicycles etc						
38	Petrol and engine oils for cars						
39	House rent						
40	Utility bills (water, telephone etc)						
41	Cigarettes, tobacco etc						
42	Remittances paid						
43	Match boxes						
44	Debt payments						
45	Ceremony and other entertainments						
46	Payment for land rent in cash						
47	Other, specify.....						

PART 10: ACCESS TO FINANCIAL CAPITAL, INFORMATION AND INSTITUTIONS

Section A: Household credit need and sources during 2010/11 cropping year. If the credit is in non-cash form, indicate the cash equivalent or value.

Activity	Needed credit? **Codes A**	If **No** in column 2, then Why? **Codes B**	If **Yes** in column 2, then did you get it? **Codes A**	If **NO in column 4**, then why not? **Rank 3 (codes C)**			If **Yes in column 4**				
				1st	2nd	3rd	Source of Credit, **Codes D**	How much did you get **(ZMK)**	Did you get the amount you requested **Codes A**	Annual interest rate charged **(%)**	Debt outstanding including interest rate at end of season **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Buying seeds											
2. Buying fertilizer											
3. Buy herbicide and pesticides											
4. Buy farm equipment/implements											
5. Invest in transport (bicycle etc)											
6. Buy oxen for traction											
7. Buy other livestock											
8. Invest in irrigation system											
9. Invest in seed drill or minimum tillage system											
10. Non-farm business or trade											
11. To pay land rent											
12. Buy food											
13. Consumption needs (health/education/travel/tax,)											

Codes A
0. No
1. Yes

Codes B
1. Not cash constrained
2. Activity is not profitable
3. Never thought of this investment
4. Other, specify.....

Codes C
0. No reason
1. Borrowing is risky
2. Interest rate is high
3. Too much paper work/ procedures
4. Expected to be rejected, so did not try it
5. I have no asset for collateral
6. No money lenders in this area for this purpose
7. Lenders don't provide the amount needed
8. No credit association available
9. Not available on time
10. Other, specify……

Codes D
1. Money lender
2. Farmer group/coop
3. Merry go round (chilimba)
4. Microfinance
5. Bank
6. Savings and Credit
7. Relative/friend /neighbor
8. Other, specify……..

Section B: Household savings

Saving family member **(Use family code from Part 2, page 3)**	Has bank account **(0=No; 1=Yes)**	Saving with **(Codes A)**	Total amount saved during 2010/11 **(ZMK)**
1	**2**	**3**	**4**

Codes A
1. Saving at home (personal)
2. Commercial or other banks
3. Rural micro-finance
4. Savings and credit
5. Merry go-round (chilimba)
6. Mobile phone banking
7. Saving by lending to money lender
8. Other, specify……

Section C: Access to extension services

Issue	Did you receive training or information on [……] before 2010/11? (**Codes A**)	Received training or information on […..] during 2010/11? (**Codes A**)	Main information source for 2010/11, **Rank 3** **(Codes B)**			If yes in column 3, number of contacts during 2010/11 **(days/year)**	
			Rank 1	Rank 2	Rank 3	Govt extension	Non-profit NGOs
1	2	3	4	5	6	7	8
1. New varieties of maize							
2. New varieties of legumes							
3. Pest and disease control							
4. Soil and water management							
5. Crop rotation							
6. Minimum tillage							
7. Leaving crop residue in the field							
8. Adaptation to climate change							
9. Irrigation							
10. Crop storage pests							
11. Output markets and prices							
12. Input markets and prices							
13. Collective action/farmer organization							
14. Livestock production							
15. Family health							
16. Sanitation							
17. Food processing							
18. Family planning							
19. Tree planting							

Codes A	**Codes B**				
0. No	1. Government extension service	4. NGOs	7. Farmer field school	10. Mobile phone	13.Traders/Agro-dealers
1. Yes	2. Farmer Coop or groups	5. Private Company	8. Radio/TV	11. ZNFU	14. Other, specify.....
	3. Neighbour/relative farmers	6. Research center	9. Newspaper	12. Farmer's training centers	

Section D. Market access

Crop	Did you get market information before you decided to sell the crop? **(Code A above)**	If **Yes** in column 2, where did you get the information? (**Code B above**) Rank 3	Ever failed to sell due to lack of buyers or poor price? **Codes A above**		No. of buyers who came to buy at farm gate last season (2010/11)				If you did not sell to some of these buyers, then why? **Codes C below** (Rank 3)			
			Lack of buyers	Poor price	Assemblers and/or brokers	Wholesalers	Farmer group or coops	Consumers	Assemblers or brokers	wholesalers	Farmer group or coops	Consumer
1	2	3	4	5	6	7	8	9	10	11	12	13
1. Maize												
2. Common beans												
3. Pigeonpea												
4. Groundnut												
5. Soybean												
6. Cowpea												

Codes C:		
1. No buyer came	2. Price offered was low	4. Unable to meet the desired quality
	3. Unreliable scale or weight	5. Other, specify……

Section E: Constraints in accessing key inputs and crop production (SIMLEZA crops only)

Input and production constraints	Maize		Common Beans		Groundnut		Cowpea		Soya beans	
	Constraint? **Codes A**	Rank its importance (only those with **Yes** in column 2)	Constraint? **Codes A**	Rank its importance (only those with **Yes** in column 4)	Constraint? **Codes A**	Rank its importance (only those with **Yes** in column 6)	Constraint? **Codes A**	Rank its importance (only those with **Yes** in column 8)	Constraint? **Codes A**	Rank its importance (only those with **Yes** in column 10)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. Timely availability of improved seed										
2. Prices of improved seed										
3. Quality of seed										
4. Availability of credit to buy seed										
5. Timely availability of fertilizer										
6. Price of fertilizer										
7. Availability of credit to buy fertilizer										
8. Access to markets and information										
9. Reasonable grain prices										
10. Drought										
11. Floods										
12. Pests										
13. Diseases										
14. Soil fertility										

Codes A: 0. No; 1. Yes

SECTION F: Rainfall assessment in the last 3 years

1. Did the rainfall season come on time? **(Codes A above)** ……..……..
2. Was there enough rain at the beginning of the growing season? **(Codes A above)**…….....
3. Was there enough rain during the growing season? **(Codes A above)**.....
4. Did the rains stop on time? **(Codes A above)**.....
5. Did it rain near the harvest time? **(Codes A above)**.....

ANNEX 1: CROP CODES

SIMLEZA Crops	**Other crops**		
1. Maize	7. Cashew nuts	26. Sweet potato	45. Eucalyptus
2. Common bean	8. Bambara nut	27. Onion	46……
3. Soybean	9. Mixed beans	28. Gralic	47……
4. Pigeonpea	10. Velvet beans	29. Pepper(Paprika)	48……
5. Groundnut	11. Rice	30. Tomato	49……
6. Cowpea	12. Sorghum	31. Ginger	50……
	13. Millet	32. Cabbage	51……
	14. Rice	33. Kale	52……
	15. Popcorn	34. Carrot	53……
	16. Sunflower	35. Pumpkin	54……
	17.Sesame	36. Tobacco	55……
	18.Linseed	37. Cotton	56……
	19.Rapeseed	38. Pineapple	57……
	20. Nigerseed	39. Coffee	58……
	21. Wheat	40. Chat (*khat*)	59……
	22. barley	41. Banana	60……
	23. Kenal	42. Orange	
	24. Cassava	43. Mango	
	25. Irish potato	44. Sugar cane	

ANNEX 2: CROP VARIETY CODES

Maize			**Soya bean**	**Cowpea**	**Groundnut**	**Pigeonpea**	**Beans**	**Other Crops**
1. AFRIC 1	38. MRI 714	73. SC 513	101.KELEYA		131.Chalimbana	141…..……	151.Chambeshi	400. Local
2. AFG 4611	39. MRI 724	74. SC 525	102.MAGOYE	121.LUTEMBWE	132.MGV-4	142…….	152.Lyambai	
3. AFG 4663	40. MRI 734	75. SC 602	103.SOPRANO	122.BUBEBE	133.FLAMINGO	143…….	153.Kabulangeti	
4. DK 8031	41. MRI 744	76. SC 604	104.SAFARI	123……	134.CHIPEGO	144…….	154.Lukupa	
5. DKC 8033	42. MRI EP	77. SC 621	105.HERNON 147	125……	135.NYANDA	145…….	155.Pan 148	
6. DKC 8053	43. MRI MP	78. SC 633	106.SOLITAIRE	126……	136.MGV-5	146..……	156…….	
7. DKC 8073	44. PAN 53	79. SC 704	107.STORM	127……	137…….	147..……	157…….	
8. DK 8051	45. PAN 57	80. SC 713	108……	128……..……..	138…….	148…..……	158…….	
9. DK 8071	46. PAN 61	81. ZMS 402	109……	129……..……	139…….	149…..……	159……..	
10. GV 408	47. PAN 64	82. ZMS 421	110……	130……	140……..	150…….	160……..	
11. GV 512	48. PAN 67 (Africa queen)	83. ZMS 510	111……					
12. GV 607	49. PAN 69	84. ZMS 521	112……					
13. GV 702	50. PAN 77	85. ZMS 528	113…….					
14. GV 703	51. PAN 4M-17	86. ZMS 602	114…….					
15. Pool 16	52. PAN 4M-19	87. ZMS 600	115……					
16. MMV 400	53. PAN 6M-55	88. ZMS 606	116……					
17. MMV 600	54. PAN 7M-97	89. ZMS 607	117……..					
18. MM 441	55. PAN 8M-91	90. ZMS 616	118…….					
19. MM 501	56. PAN 8M-95	91. ZMS 621	119…….					
20. MM 502	57. PAN 413	92…….	120…….					
21. MM 603	58. PAN 6017	93…….	.					
22. MM 604	59. PAN 5503	94…….						
23. MM 606	60. PAN 6243	95……..						
24. MRI 404	61. PAN 6363(Chipolopolo)	96……..						
25. MRI 455	62. PAN 6966	97……..						
26. MRI 514	63. PAN 7369	98……..						
27. MRI 534	64. PAN 7353	99……..						
28. MRI 594	65. PAN 7351	100…….						
29. MRI 611	66. Pool 16							
30. MRI 614	67. PGS 53							
31. MRI 624	68. SC 201							
32. MRI 634	69. SC 401							
33. MRI 651	70. SC 403							
34. MRI 644	71. SC 405							
35. MRI 694	72. SC 407							
36. MRI 704								
37. MRI 711								

FARM DESIGN DATA SHEET 2014

Information for household ID number

	Name
Province	
District	
Block	
Camp	
Village	

GPS Latitude	N	.
GPS Longitude (circle E or W)	E W	.
Altitude		

Introduction

Hello, my name is _____. I work for SIMLEZA Africa RISING and we are carrying out a survey of farmers in the Eastern province in Zambia. The survey is intended to gather information necessary for initiating and testing agricultural interventions to enable Sustainable Intensification (SI) of the agricultural sector and reduce poverty, hunger, and undernutrition. Your household is one of 20 households in Zambia that have been selected to participate. The results are confidential and will only be used for research purposes. We would like about 2 hours of your time to ask you some questions.

PLEASE DON'T FORGET TO TAKE PHOTOS OF THE FARMS, FARMERS, FIELDS, ANIMALS, OR OTHER INTERESTING FEATURES

Information on household

Name of head of household			
Name of respondent (if not head)			
Relationship to head (if not head)			
Was translator used? 1. Yes 2. No		Translator's name	
Phone numbers			
House number			
Description of location of house			

Survey Staff Details

1. NAME OF ENUMERATOR: .....

2. TIME INTERVIEW START :

3. TIME INTERVIEW END :

4. DATE OF INTERVIEW: / /
DD MM YYYY

Sheet A: PEOPLE

Records kept [ ] yes or no

Use a sheet of "monthly" to indicate monthly and/or seasonal patterns

Years [ ]

Residents/Family members

Name	**Gender**	**Age**	**Farm Labor (availability for farm work)**		**Household Work**	**Off Farm Labour**		**Off Farm Wages**		**at School**	**Highest school level achieved**
	(M/F)	Years	days	h/day	h/day	days	h/day	amount	Units of time	yes/no	

Non-Residents/ Hired labor

Name	**Gender**	**Age**	**Labor (availability for farm work)**		**Wages**		**Activities**
	(M/F)	Years	days	h/day	amount	Units of time	What work is done?

Sheet B: FIELDS **use more sheets if needed**

One Table per field (also for currently uncultivated land!)

Field name	**Area** Units!	**Price if rented in** mention per unit!	**Price if hired out** mention per unit!	**Productivity(1-5)** 1-Low 5-High	**Field use (last 12 months)**		**Crop name use code no.**	**Productivity(1-5)** 1-Low 5-High	**Intercropped with**	**Productivity(1-5)** 1-Low 5-High
					Whole field	1				
Person responsible					(put X if used in parts)	2				
Tillage activities:		QB5				3				
by hand		with hoe		only if used	Part 1	1				
				in parts:	(%:)	2				
by oxen		with ripper				3				
					Part 2	1				
by tractor		with plough			(%:)	2				
						3				
other		other			Part 3	1				
					(%:)	2				
Ridges?		yes or no				3				
Cons. Agric		Mulching			Part 4	1				
		Minimum Tillage			(%:)	2				
		Crop Rotation				3				

One Table per field (also for currently uncultivated land!)

Field name	**Area** Units!	**Price if rented in** mention per unit!	**Price if hired out** mention per unit!	**Productivity(1-5)** 1-Low 5-High	**Field use (last 12 months)**		**Crop name use code no.**	**Productivity(1-5)** 1-Low 5-High	**Intercropped with**	**Productivity(1-5)** 1-Low 5-High
					Whole field	1				
Person responsible					(put X if used in parts)	2				
Tillage activities:		QB5				3				
by hand		with hoe		only if used	Part 1	1				
				in parts:	(%:)	2				
by oxen		with ripper				3				
					Part 2	1				
by tractor		with plough			(%:)	2				
						3				
other		other			Part 3	1				
					(%:)	2				
Ridges?		yes or no				3				
Cons. Agric		Mulching			Part 4	1				
		Minimum Tillage			(%:)	2				
		Crop Rotation				3				

Sheet C: CROPS **Use more sheets if needed**

Use a sheet of "monthly" to indicate monthly and/or seasonal patterns in labor or cultivation costs

Crop name	Cultivar	Improve/Traditional	Cultivation costs	Productivity (1-5)	Yield	Shelled	Crop Products	Product use (give %)													If Sold		
								Home	Animal feed				Mulch	Bedding	Fire	Burned	Processed into...		Sold		Price	Units	Who is
		(I/T)	(seeds, fuel etc.)	1-Low 5-High	Units!	Unshelled	(don't forget residues!)	Cons	Grazed	Fresh	Dried	Silage			Wood	on field	Product name	%					responsible?

Fertilizers used (mention amounts with units!):

poor ave. good

Fertilizers used (mention amounts with units!):

poor ave. good

Fertilizers used (mention amounts with units!):

poor ave. good

Fertilizers used (mention amounts with units!):

poor ave. good

Fertilizers used (mention amounts with units!):

poor ave. good

List candidate crops or innovations that the farmer would be interested in, give farmer's explanation why:

Sheet C1: Crop Labour Use more sheets if needed

(Inter) Crop			Field name	
	Total Labour in person days by			
Labour Tasks	HH Males	HH Females	Hired Males	Hired Females
Land Preparation				
Planting				
Weeding				
Harvesting				
Shelling & Threshing				
Processing				
Sales				

(Inter) Crop			Field name	
	Total Labour in person days by			
Labour Tasks	HH Males	HH Females	Hired Males	Hired Females
Land Preparation				
Planting				
Weeding				
Harvesting				
Shelling & Threshing				
Processing				
Sales				

(Inter) Crop			Field name	
	Total Labour in person days by			
Labour Tasks	HH Males	HH Females	Hired Males	Hired Females
Land Preparation				
Planting				
Weeding				
Harvesting				
Shelling & Threshing				
Processing				
Sales				

(Inter) Crop			Field name	
	Total Labour in person days by			
Labour Tasks	HH Males	HH Females	Hired Males	Hired Females
Land Preparation				
Planting				
Weeding				
Harvesting				
Shelling & Threshing				
Processing				
Sales				

Sheet D: ANIMALS

Use more sheets if needed

Use a sheet of "monthly" to indicate monthly and/or seasonal patterns in animal numbers and labor and movements

Animal type	Breed	Traditional Improved T/I	Number on farm now	In the last 12 months how many were					Costs involved in keeping one of this type per year	Productivity (1-5)	Time spent by animals									
				Born	Died	Bought	Sold	other gift/theft		1-Low 5-High	Stable		Yard		Farm grazing land		Farm crop stubble		Off-farm	
											days	h/day	days	h/day	days	h/day	days	h/day	days	h/day

QD6

List candidate animal type or aimal husbandry innovations that the farmer would be interested in, give farmer's explanation why:

Sheet D1: Animal Labour and Productivity

	Total Labour in person days by				Products	Yields	unit time	Product use (give % of total product)				If Sold		
						units!	(per)	Home Use	Processed into...		Sold	Price	Specify	Who is
Animal types	HH Males	HH Females	Hired Males	Hired Females				%	(give product name)	%	%		unit	responsible

Sheet E: MANURES

	Collection (of 100% produced)		Amount	Use of collected manure (of 100% collected)			If sold		Storage (tick method)				Storage	Added Material
	Left, no use	Collected	collected	Fire wood	Fertilizer	Sold	Price	Unit	Applied	Storage			Duration	(straw, leaves, branches, etc.)
	%	%	Units!	%	%	%			Fresh	Open	Roofed	Sealed	No. of Weeks	specify amount and units
Yard														
Stable														
Grazing Land														
Crop Land														

If less than 100% is collected: Ask reason for not collecting 100%

Sheet F: IMPORTS **Use more sheets if needed**

IMPORTED ORGANIC MATTER LIKE CROP PRODUCTS, LEAVES AND BRANCHES, WOOD etc. (EITHER BOUGHT, COLLECTED OR GIVEN)

Products	Amount		Product use (give %)						Price	Units
	Quantity	units	Home consump	Animal feed	Mulch	Bedding	Fire wood	Burned on field		

FERTILIZERS AND PESTICIDES

Products	Amount		Price	Unit
	Quantity	Units		

Sheet G: TOOLS AND MACHINERY

	Number							
Name	Owned	Rented	Rental cost	Rental unit	Other	Age Years	Approximate Value	Who uses the tool
Cutlass								
Panga Machete								
Axe								
Pick-axe								
Sickle								
Knapsack Sprayer								
Shovel								
Hoe								
Winnower								
Push Cart								
Animal Cart								
Yoke								
Harrow								
Ox Ridger								
Disc Plough								
Ox Plough								
Ripper								
Treadle Pump								
Power Tiller								
Tractor								
Bicycle								
Motorbike								
Car								
Cell Phone								
Radio								
TV								
Solar Panel								

Sheet H: BUILDINGS **mention all individual buildings**

Name	Tenure (tick one)						Approximate value
	Owned	Rented in	Rented out	Rental cost	Rental Unit	Other	

Categories:
- animal houses
- storage rooms/houses
- tools / machine storage
- other buildings/sheds

Sheet I: Dreams Desires Challenges Constraints

Are you planning to expand or reduce your farming area?

Expand	Reduce	Neither

Explain answer to above question -EXPAND

- ☐ profits are expected to increase
- ☐ to grow further crop types
- ☐ land is relatively cheap
- ☐ land is easy to buy or sell
- ☐ hired labour is cheap and will be used to cultivate that land
- ☐ there is enough family labour available to cultivate the additional land
- ☐ to harvest more and become more food secure
- ☐ land is a good investment itself (cash buffer)
- ☐ contract of land rented-out ended, but no one was found to rent the land after that
- ☐ other _____

Explain answer to above question -REDUCE

- ☐ the land has a high price and selling it will provide a considerable additional income at this point in time
- ☐ land has a low price, but financial pressure is the underlying reason for this step
- ☐ hired labour is needed to cultivate that land, but it has become too expensive
- ☐ family claims (children or other family members are entitled to a share of the land)
- ☐ rental contract ended (of rented-in land)
- ☐ other _____

Compared to other farmers you know: Do you think you have higher or lower yields?

Higher	Lower	Same

It is important to me that I achieve higher yields than my neighbour

strongly agree	agree	neutral	disagree	strongly disagree

It is important to me that I achieve higher yields than my relatives who live further away.

strongly agree	agree	neutral	disagree	strongly disagree

If a neighbour farmer achieves higher yields, I am confident to get their advice on how I also can achieve better yields

strongly agree	agree	neutral	disagree	strongly disagree

I would trust the advice of neighbour farmers

strongly agree	agree	neutral	disagree	strongly disagree

I give honest advice to my neighbour if I found an improved technique, crop variety or animal type.

strongly agree	agree	neutral	disagree	strongly disagree

What challenges and constraints do you face?

- ☐ Low soil fertility, moderating productivity
- ☐ Crop pests and diseases
- ☐ Livestock pests and diseases
- ☐ Fluctuating market prices
- ☐ Lack of access to support in farming (extension services)
- ☐ Lack of access to credits
- ☐ High cost of good seeds
- ☐ High costs of fertilizers
- ☐ High costs of pesticides
- ☐ Fertilizers are unavailable
- ☐ Pesticides are unavailable
- ☐ Good seeds are unavailable
- ☐ High post-harvest losses
- ☐ Lack of processing equipment
- ☐ Changing rainfall patterns due to climate change (unpredictable climate)
- ☐ other _____

Sheet J: Additional Questions

Could the farmer incorporate more crop residues as mulch? ☐ yes ☐ no

if yes, why does he/she not do this?

- ☐ labour requirements are too high for this task
- ☐ residues are indispensable as feed for livestock
- ☐ it is not recognized as beneficial for yields
- ☐ other _____

Are all three principles of Conservation Agriculture practiced? ☐ yes ☐ no

if no, which practices are not done?

- ☐ Mulching
- ☐ Minimum Tillage
- ☐ Crop Rotation

Why are these practices not done?

- ☐ it is not recognized as beneficial for yields
- ☐ lack of knowledge on how to do it right
- ☐ lack of tools
- ☐ other

Does farmer grow intercrops? ☐ yes ☐ no

if not, why not?

- ☐ Not enough land
- ☐ Not enough money to buy different seeds
- ☐ Lack of knowledge of many crops
- ☐ It is too complex to take care of a bigger number of crops
- ☐ No incentive to grow further crops
- ☐ Other _____

Could the farmer feed more crop residues to animals? ☐ yes ☐ no

if yes, why does he/she not do this?

- ☐ labour requirements are too high for this task
- ☐ residues are indispensable as green manure
- ☐ it is not recognized as a suitable feed
- ☐ There are no animals to eat residues
- ☐ other _____

What obstacles stand in the way of increasing the number of crops grown?

- ☐ Not enough land
- ☐ Not enough money to buy different seeds
- ☐ Lack of knowledge of many crops
- ☐ It is too complex to take care of a bigger number of crops
- ☐ No incentive to grow further crops
- ☐ Other _____

Is manure stored sealed from air and water? ☐ yes ☐ no

if not, why not?

- ☐ Did not consider this technique
- ☐ It would require too much labour
- ☐ It would cost too much money
- ☐ There are no facilities for this technique
- ☐ The materials required to construct such a facility are not available
- ☐ other _____

Sheet K: MONTHLY

1	jun-13							
2	jul-13							
3	aug-13							
4	sep-13							
5	okt-13							
6	nov-13							
7	dec-13							
8	jan-14							
9	feb-14							
10	mrt-14							
11	apr-14							
12	mei-14							

Sheet L: Codes

Crop codes

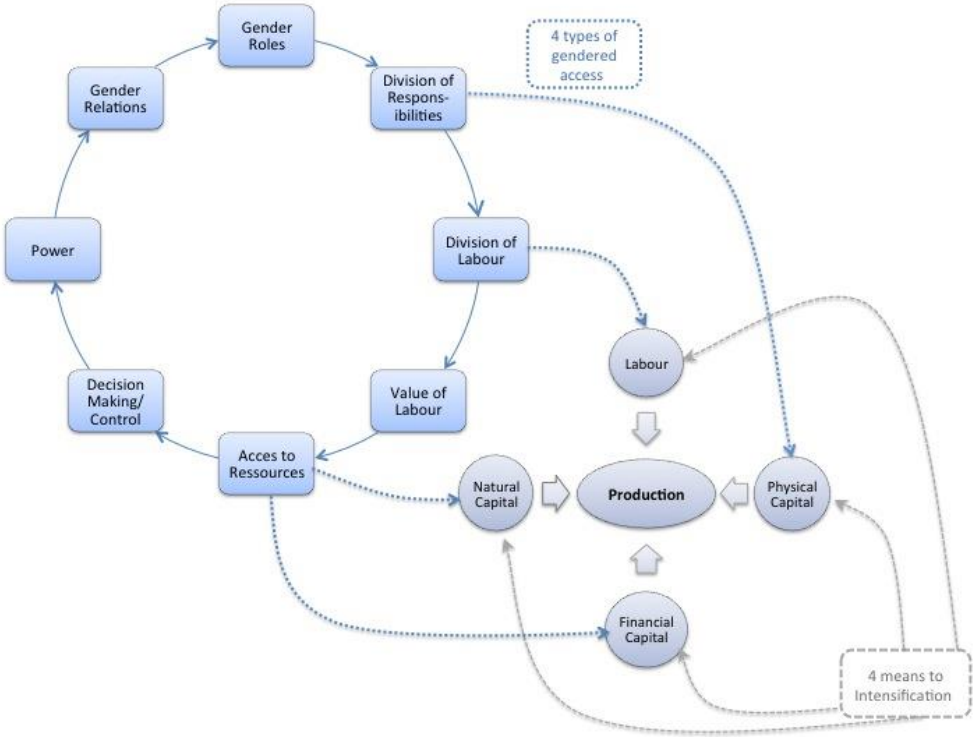
Cereals	
11	Maize
12	Wheat
13	Pearl millet (mchewere)
14	Sorghum
15	Finger millet (mawere)
16	Rice
19	Other grains
Pulses and nuts	
21	Bean
22	Soyabean
23	Pigeonpea (nandolo)
24	Chick-peas
25	Cow-peas
26	Peas
27	Groundnut
28	Ground bean (nzama)
29	Bambara nuts
30	Other pulses and nuts
Vegetables	
31	Cabbage
32	Tomatoes
33	Tanaposi
34	Nkhwani
35	Therere/okra
39	Other vegetables

Root and tuber crops	
41	Onion
42	Potato
43	Sweet potato
44	Garlic
45	Cassava
49	Other root and tuber
Perennial crops	
51	Avocado
52	Banana
53	Mango
54	Orange
55	Pawpaw/Papaya
56	Coconut
57	Oil-palm
58	Sugar cane
59	Other perennial
Other crops	
61	Cotton
69	Other crops
Other land use	
71	Fallow
72	Pasture/grazing
73	Planted fodder
74	Planted trees
75	Natural trees
79	Other uses

Animal Codes

100	Draught cattle
101	Bulls -local-
102	Bulls -improved-
103	Fattening cattle -local-
104	Fattening cattle -improved-
105	Cows -local-
106	Cows -improved-
107	Heifers -local-
108	Heifers -improved-
109	Calves -local-
110	Calves -improved-
111	Horse/donkey/mule
112	Camel
113	Goats -local-
114	Goats -improved-
115	Sheep
116	Pigs -local-
117	Pigs -improved-
118	Chickens
119	Fish
120	Other livestock
121	Honey bees

Towards integrated assessment of gender relations in farming systems analysis



Karoline Hemminger

August 2014

Farming Systems Ecology Group
Droevendaalsesteeg 1 – 6708 PB Wageningen - The Netherlands

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Towards integrated assessment of gender relations in farming systems analysis

Name student:	KAB (Karoline) Hemminger
Registration number:	860604322110
Credits:	30
Code number:	FSE-80430
Period:	February to August 2014
Supervisors:	Dr.ir. JCJ (Jeroen) Groot, Farming Systems Ecology
	Dr.ir. BB (Bettina) Bock, Rural Sociology
Professor/Examiner:	Prof. Dr. ir. PA (Pablo) Tittonell, Farming Systems Ecology

Preface

I would like to express my gratitude to my supervisors Bettina Bock and Jeroen Groot for the useful comments, remarks and their support throughout the learning process of this master thesis.
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I am grateful to the Farming Systems Ecology Group and the Africa RISING Program for the opportunity to travel to Zambia. It was a pleasure to work with and learn from Mirja Michalscheck and Carl Timler during this field trip.
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Karoline Hemminger

Abstract

Gender sensitivity in agricultural research and development is considered to be crucial for effectively contributing to gender equity, but also for improving the effectiveness of agricultural interventions in terms of poverty alleviation and improvement of household nutrition. Yet farming systems research often neglects the analysis of gender relations even when working in the context of smallholder households. More than 30 years of research have repeatedly revealed that women hold an important role in smallholder agricultural production. In many cases, women contribute the majority of agricultural labour and are responsible for certain domains of production on which they have special local knowledge. Their responsibility for household nutrition has often been emphasized. Yet, because farming systems analysis and the modelling tools used for it often focus only on biophysical and economic data, women's special needs, preferences and constraints are not considered when innovations for the design or improvement of farming systems are developed. Therefore it is the aim of this study to show options for integrating the analysis of gender relations in farming systems research.

The study focuses on the conceptualization, i.e. the identification of relevant gender issues and their causal relations based on literature review, expert interviews and qualitative interviews with female farmers that were performed during a two week case study in the Eastern Province of Zambia, location to the SIMLEZA project of the Africa RISING program („Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia" and "Africa Research in Sustainable Intensification for the Next Generation" by CIMMYT and IITA).

The findings are presented in a conceptual framework that illustrates the complex mutual effects of agricultural intensification and gender relations. Based on this, possible extensions or changes to model based farming systems analysis were identified, such as the inclusion of sex-disaggregated labour profiles or the analysis of separate economic units within one household to capture independent female income. Furthermore it can be concluded that understanding and commitment of researchers to gender matters is a necessary precondition to reach gender sensitivity in agricultural research. The presented conceptual framework hopes to facilitate this.

Contents

1. Introduction

“If we invest in women, they can feed the world” -

This is what the Bill and Melinda Gates foundation concluded from two recent flagship reports that focused on gender and agriculture (Ley, 2012): The State of Food and Agriculture 2010–2011 report of the Food and Agriculture Organization (FAO) highlights that women constitute on average 43% of the agricultural labour force in the so called developing countries but are disfavoured in their access to land, inputs and technologies. Achieving equal access to resources for female farmers holds the opportunity to raise overall agricultural production in developing countries by 2.5 – 4 %. Raising women’s yields would also have wider effects for improved rural livelihoods, because it was shown that an increase in women’s income by US$ 10 could lead to the same improvements in their children’s health and nutrition as an increase of male income by US$ 110 (FAO 2011, FAO and Farming First, n. d.). The 2012 World Development report by the World Bank argues that besides the fact that ending inequality of women and men is a core development goal in its own right, it is also “smart economics” (The World Bank 2011, p.3). This reaffirms FAOs conclusion that gender equality can enhance productivity. It seems that gender has regained its prominent role in the international research and development agenda.

The interest in gender in agriculture and development is not new, the first studies on rural gender issues were published in the 1970s (Bock 2006). Since then ’gender' has been institutionalized by donor agencies, non-governmental agencies and universities (Cornwall et al. 2007). Considering gender has become an imperative when writing strategy papers or research proposals (Kauck et al. 2010). While the position of rural women has improved in some places, interventions in the past have often been limited to a few specialized women’s projects or efforts for gender mainstreaming with limited effectiveness (Bock 2006, Meinzen-Dick and Quisumbing 2013). In this context, gender mainstreaming refers to the process of assessing the different effects of any planned legislation, policy or program on women and men and thus integrating gender analysis systematically in all public spheres (United Nations 1997). Critical voices argue that the gender mainstreaming approach has led to a number of “simplistic slogans” (Cornwall et al. 2007, p.1) - like the one stated above „if we invest in women, they can feed the world“- but that proclaimed intentions often do not translate into actual practice (Bock 2014). Another point of criticism is that gender effects are often analysed separately without taking into account how gender intersects with class, age, ethnicities or other 1ocal attributes.

Critics see that this will result in not properly depicting the situation of those who are discriminated because of several attributes and thus falsely targeted policies. They call for an "Intersectionality approach" that aims to integrate the analysis of all factors influencing a person´s social role (Norris et al. 2010, Hippert 2011).

These shortcomings of the gender mainstreaming approach are also known within the Consultative Group on International Agricultural Research (CGIAR). Having launched its first Gender Program in 1990, twenty years later a scoping study on past achievements in gender analysis revealed only mixed successes. The authors acknowledged that there have been abundant recommendations for mainstreaming gender within the CGIAR system. Some of the 15 CGIAR research centres worldwide were successful in incorporating gender analysis, but they find that most CGIAR centres have not had a clear gender policy and have not consistently published gender-specific research findings. The authors of the study assessed that a common understanding of gender is lacking and that a number of false assumptions have chronically impeded constructive mainstreaming attempts, for instance:

a) That gender issues are irrelevant to research concerning agricultural production and should only be studied by social sciences
b) That only men are farmers and women are not influenced by agricultural research and development.
c) That households constitute one unit in which resources are shared and decisions about labour and resource use are made cooperatively and equitably among male and female household members (Kauck et al. 2010).

Ample evidence exists that proves that these assumptions are really wrong as presented in Box 1. Following this study, the CGIAR developed a new gender strategy, which affirms the commitment to deliver research results that benefit poor rural women. This is to be achieved by integrating gender analysis in all Consortium research programs for example by demanding the development of a detailed gender strategy that includes accountable targets by every approved research program (CGIAR Consortium Board 2011).

Box 1: Why gender matters

a) Gender is relevant to most areas of agricultural research.

While some topics, as for instance mapping the genome analysis of certain crops, are indeed gender neutral, a lot of agricultural researchers assume irrelevance of gender for their field of work much too quickly (Kauck et al. 2010). For instance, also breeding new varieties should take into account gender aspects. Women and men often have different preferences for maturation periods, yields, tastes and colours, relating to their different resources and needs but also to their different knowledge about processing and nutritional requirements. In Zimbabwe, unequal access to credit and formal markets restricted the adoption of high-yielding maize varieties to only men. Women chose to use open-pollinated maize varieties, for which they did not have to take loans for fertilizers and seeds (Quisumbing and Pandolfelli 2010). A study that looked at adoption rates of new agricultural practices in Ethiopia found that all of the proposed innovations had raised women´s labour burden unequally to that of men (Teklewold et al. 2013). Considering gender beforehand is likely to have produced better adoption rates. Along with this reasoning, also the FAO recommends production interventions to be gender sensitive in order to reach higher effectiveness (FAO 2011).

b) Women are farmers

Ester Boserup argued as early as 1970, that the assumption of farmers being mostly men and women being only responsible for childcare and food preparation is a bias affected by western culture. She criticised that many development workers address only men and only men profit from new technology while women's labour productivity relatively declines (1982). Many other studies found that the work women did in agriculture was not recognized and coined the phrase of women being "invisible farmers" (Sachs 1983). Despite increasing evidence of women´s large share in the agricultural labour force, women´s contribution to farming often still remains invisible, for example: a recent development project in Mozambique distributed dairy cows to households and targeted training and control of dairy income only towards men. As dairy farming demands substantial amounts of women´s labour, this unequal treatment created tension within households. Project workers only recognized their fault, when a female farmer deliberately starved a cow to death as a way to express her frustration about her labour contribution not being valued (Meinzen-Dick and Quisumbing 2013).

c) Decision making within households and labour division by gender is culturally specific.

A recent discussion paper of the International Food Policy Research Institute (IFPRI, also a member of the CGIAR), looked at the division of labour between women and men in various farming systems in Sub-Saharan Africa. Who does which tasks - whether it be planting, weeding, harvesting, processing, marketing or food preparation - differs dependent on local context and culture. How the rights of women and men to access, manage and own key resources are organized varies accordingly. The paper proposes the introduction of a household typology that differentiates between: male managed; female managed, jointly managed and separately managed farming systems (see section 5.1.2) Mapping of the dominant household structure of a region is hoped to inform researchers and development workers about the gendered aspects of farming and allow them to target appropriate decision makers (Meinzen-Dick et al. 2012)

Case Study: Africa RISING

Africa RISING („Africa Research in Sustainable Intensification for the Next Generation) is a research-for-development program funded by the US government. It has three regional projects that are led by research institutes of the CGIAR. The project in East and Southern Africa with intervention sites in Malawi, Tanzania and Zambia is led by the International Institute of Tropical Agriculture (IITA). The case study of this thesis was performed in the project sites in Zambia. Coherent to the CGIARs commitment to conduct research that benefits women, Africa RISING aims to improve food, nutrition, and income security particularly for women and children. This is to be achieved by sustainably intensifying farming systems of the targeted smallholder households (Timler et al. 2014). In order to suggest measures for sustainable intensification- that ensures the wellbeing of farming households while conserving or enhancing the natural resource base- it is necessary to analyse the farming system in an interdisciplinary way.

Model-based research framework for farming systems analysis

The system level approach of Wageningen University is seen as a valuable tool for interdisciplinary research (Le Borgne 2014). Therefore the Farming Systems Ecology (FSE) and Plant Production Systems (PPS) groups of Wageningen University were asked to perform a characterization of farming systems in the Africa RISING intervention sites. This characterization has the purpose to provide recommendations that are targeted at the specific constraints of different farms and is conducted following a research framework with the steps: rapid characterization, detailed characterization, exploration of innovations and systems (re)design.

Rapid characterization: Smallholder farming systems in Africa are highly diverse not only because of geographic differences e.g. in climate and soil fertility, but also because of farmer's different livelihood aspirations and the varying accessibility to critical production factors such as land, labour or credit. As it is not possible to analyse every individual farm, survey-based data are used for a rapid characterization of farms. On the basis of these data a functional typology is created. Farms of one type are ideally very similar in respect to characteristics that were identified as crucial for the farming system in the area, e.g. ressource endowment in terms of land or animal ownership, or production orientation in terms of the types of crops that are cultivated.

Consequently a detailed characterization is performed for a small number of farm-households of each type. The data collected during the rapid and detailed characterization are then used for model-based analysis and exploration of possible consequences of different options for intensification. Based on this recommendations for a new design of the farming systems can be made (Timler and al. 2014).

Whole Farm Model: Farm DESIGN

One of the models used for analysis and exploration at farm level is Farm DESIGN (Fig. 2). While considering biophysical limitations, it allows to calculate different designs of a farming system in terms of crops cultivated and animals kept and their effect on farm income and environmental factors.

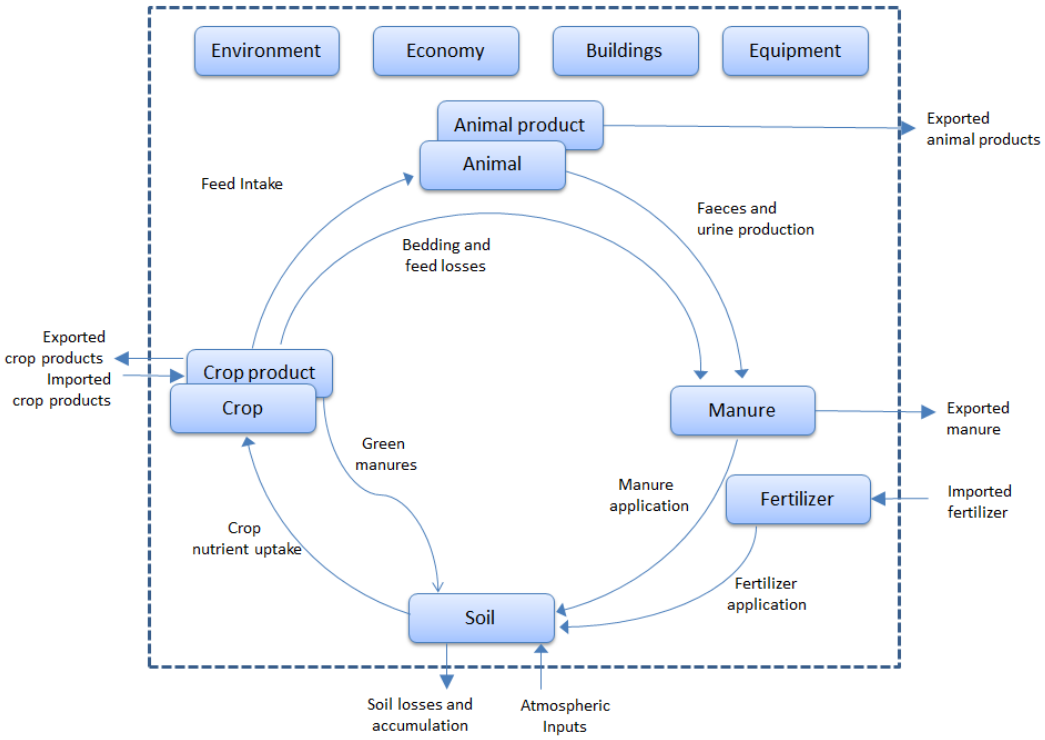

Fig.1.2. Schematic representation of the farm model and data within Farm DESIGN. The boxes indicate represent material flows quantified by the model. The dashed lines denote the farming system boundary with the external environment (Groot et al. 2012).

Due to its focus on material flows, one could assume at first sight that this research tool is gender neutral, meaning that research results will benefit men and women equally and that research results in turn will not be affected by different gender arrangements within the farm household. It is the preposition of this study that this is not the case. In fact it was already acknowledged that modelling tools do not sufficiently represent social aspects including gender (Van Ittersum et al. 2008). Especially a characterization of farming systems

that serves to identify entry points for policy or project intervention should take the specific needs and constraints of male and female farmers into account.

Farming systems are agroecosystems: ecosystems that provide the natural resource base for the livelihood of the farm household and are in turn managed and shaped by the household members. Rossing et al. describe three different roles that farmers have to take regarding their farm work: they are labourers, decision makers and owners/investors on their farm (Rossing et al. 2013). On top of this, social roles need to be taken for childcare but also for the community. How these roles are divided among household members and genders is different depending on the local context and even individual arrangements. Naturally this will affect the decision-making process as well as labour availability on the farm.

The challenge is to quantify the mutual effects between gender relations and sustainable intensification in smallholder households, which would enable the integrated assessment of gender within farming systems analysis. In doing this, it is hoped to bridge the gap between objectives proclaimed in gender strategy papers and the actual practise of agricultural research.

2. Purpose of the study

The purpose of this study is to make gendered relations within farming systems more visible and thus contribute to making farming systems analysis more gender responsive, i.e. sensitive to the gendered effects of agricultural intervention and ensuring that research activities will benefit both women and men, and that neither of them will be harmed (Kauck et al. 2010). This is to be achieved by including the assessment of gender issues in model-based frameworks for farming systems analysis.

The **General Research Question** is:

How can the assessment of gender issues be included in model-based frameworks for farming systems analysis and what would be the benefit of doing so?

This question will be answered by looking at the following specific research questions (SRQ):

1. Which gender issues are relevant for the analysis of farming systems?
2. What are the causal relations between these issues, i.e. how do they relate in a conceptual framework?
3. How can these concepts and their relations be quantified and integrated in a modelling tool?
    - 3.1 Which gender indicators already exist?
    - 3.2 How can these indicators be combined in a modelling tool?
    - 3.3. What other methods could be used to assess gender issues in model based farming systems analysis?
4. What could be benefits and possible applications of the identified extensions to the model based research framework?

The **Hypothesis** of this study is, that:

It is feasible to integrate gender issues in model based research frameworks and successful implementation will lead to farming systems analysis being more gender responsive.

3. Materials and Methods

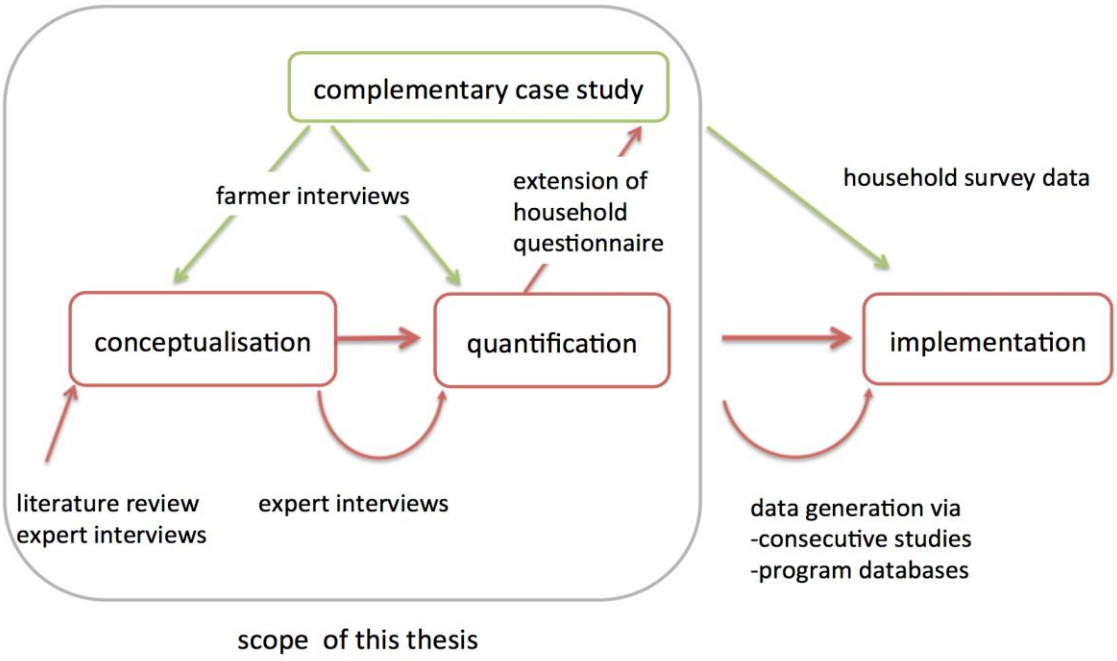

Fig. 3.1 Overview of the research process. The grey box indicates the scope of this thesis.

Bontkes (1999, p. 5) defined a model as a "*simplified picture of reality that still provides sufficient information for sound decision making*". He described four different stages of model development: Conceptualisation, Quantification, Evaluation and Implementation. The methodology of this study is based on this framework for model development. The main part of the work constitutes the conceptualisation and quantification based on literature review and the results of expert interviews. The case study was conducted in the Africa RISING project site in the Eastern Province of Zambia and serves to complement literature and expert suggestions with farmer's perception of the problem and test the possible ways of data generation for the model. While the actual implementation of the model is beyond the scope of this thesis, suggestions for possible ways of implementation are given in the conclusion.

3.1 Conceptualisation

The first step is to determine the structure of the problem. The structure of a problem is defined by the objectives to be achieved and the constraints faced within the system. Furthermore it should identify possibilities for the decision maker to intervene. This is why next to the analysts/scientists also the decision maker should be involved in the process (Bontkes 1999). This study will focus on modelling tools used at farm level. Here the farmers can be seen as decision makers (see above). But the farm level models are part of a research framework that is to generate results to inform CGIAR staff about options for sustainable intensification of farming systems at regional scale. Therefore three types of actors were involved in the conceptualisation phase: Four gender scientists, three CGIAR gender experts and 9 female farmers in the case study area. For a list of the expert interviews and the guiding questions used see Annex I and II.

The conceptualisation phase was split in three steps based on a methodology by Jabareen (2009):

1. Development of a preliminary conceptual framework based on literature review
   - Collecting relevant multidisciplinary literature
   - Identifying and categorizing key concepts
   - Identifying how the key concepts interrelate
2. Visual presentation of these relations in a conceptual framework
   - Expert interviews with gender scientists and CGIAR gender experts to adjust the developed conceptual framework.
3. Affirmation of the conceptual framework by a wider scientific audience in form of the thesis colloquium to which members of the FSE, PPS and Rural Sociology group of Wageningen University will be invited.

The colloquium presentation holds the opportunity to gain additional information in two ways: Firstly, as the developed conceptual framework is presented to a wider interdisciplinary audience, it can be asked for critical feedback on the results. Secondly members of the FSE group could be asked for suggestions for the appropriate tools for developing a new model. The activities described above aimed to answer the first two specific research questions:

1. Which concepts of gender are relevant for the analysis of farming systems?
2. What is the causal relation between these concepts, i.e. how do they relate in a conceptual framework?

The identified concepts are presented in chapter 4 and the conceptual framework in chapter 6.

3.2 Quantification

The quantification part is aimed to answer specific research question (SRQ) 3. It is based on results of literature review and interviews with the gender specialists. A literature review indicated existing indicators for gender concepts relating to smallholder agriculture (SRQ 3.1 Which gender indicators already exist?). An overview of these indicators was presented to the gender specialists during the interviews to discuss their usefulness for the model (SRQ 3.2: How can these indicators be combined in a modelling tool?). Moreover the specialists were asked for suggestions for other appropriate methods to measure the relevant issues identified in the conceptual framework analysis. (SRQ 3.3 What other methods could be used to assess gender issues in model based farming systems analysis?)

Chapter 5 of this thesis presents an overview of the relevant indicators identified through literature research and expert interviews. Together with the conceptual framework presented in chapter 6, they are used to develop suggestions for integrating the assessment of gender issues in farming systems analysis in chapter 7.

3.3 Case Study

The case study was conducted in the three districts Katete, Chipata and Lundazi in the Eastern Province of Zambia, project sites of Africa RISING (For information on the area see box 2 below). I had the opportunity to accompany Mirja Michalscheck and Carl Timler of the FSE group who were conducting a detailed household characterization of 14 households.

Based on the findings of the conceptual framework, the survey they were using was extended with questions on the sex-disaggregated requirement and availability of farm labour. The 14 households were selected according to a typology that was created based on a baseline survey of 811 households conducted by the affiliated project SIMLEZA in 2011/12 (Sustainable Intensification of Maize Legume Systems for the Eastern Province of Zambia). A principal component analysis followed by a cluster analysis of 746 of the 811 farms identified 5 different farm types based on the following characteristics:

- operated area
- tropical livestock units
- total labour inputs
- share of labour for land preparation
- share of labour for weeding
- off farm income
- crop income
- cost of hiring labour
- legume ratio (share of total operated land cultivated with legumes)
- years of experience in growing legumes
- legume score

The farm types were described as follows:

- Type 1: Low Resource Endowed, Most Labour for Land Preparation, Legume Growers, Most Food Insecure
- Type 2: Low Resource Endowed, Most Labour for Weeding, Few Legume Growers
- Type 3: Medium Resource Endowed, Most Labour for Weeding, Few Legumes Grown
- Type 4: Medium to High Resource Endowed, Highest Off-farm Income
- Type 5: High Resource Endowed, High Crop and Animal Income

(Michalscheck, 2014)

For each of the districts one farm household per type was selected based on how closely the farm data in the characteristics listed above fitted the type average. Because it was assumed that the household-head was most knowledgeable about the family farm, the two FSE researchers conducted the survey for the detailed household characterization with him, or in case of female-headed households with her. To complement the information given by the male household heads with a female perspective, it was planned to ask the wife of each male respondent for a qualitative interview. Ideally there would have been one survey and

one qualitative interview for each household conducted at the same time with the help of two translators. Yet because there was only one translator available on some days and because in some farms there was only one adult household member available to talk to us, this was only achieved in 5 of the 14 households (Chipata 4, Katete1, 2 and 5 and Lundazi 5, see table 3.1 and figure 3.2) On the occasions when there was only one household member available, the translator managed to ask female farmers of the same village to volunteer for an interview. As there was no detailed household characterization conducted for these women, the interviews with them are called additional (additional A, B and C, see table 3.1 and figure 3.2) In contrast to the surveys, all open interviews were conducted with a female translator to allow the discussion of sensitive topics.

Table 3.1 List of Farmers Interviews

Location: District	Type	Respondents ID	Survey/ Interview	Gender of Respondent	Gender of Household head
Chipata	1	C1m	Survey	male	male
	2	C2m	Survey	male	male
	3	C3f	Survey	female	male
	4	C4m	Survey	male	male
	n.n.	C4f	Interview	female	female
	5	C5f	Survey	female	male
Katete	1	K1m	Survey	male	male
		K1f	Interview	female	male
	2	K2m	Survey	male	male
		K2f	Interview	female	male
	3	K3f	Survey	female	male
	4	K4m	Survey	male	male
	5	K5m	Survey	male	male
	5	K5f	Interview	female	female
	n.n.	a	Interview	2*female	2*female
	n.n	b	Interview	female	female
Lundazi	2	L2f	Survey	female	female
	3	L3m	Survey	male	male
	4	L4m	Survey	male+female	male
	5	L5m	Survey	male	male
		L5f	Interview	female	male
	n.n.	c	Interview	female	male

The open interviews focused on the gender-specific division of farm and household labour, the decision making on household expenditure and what suggestions women had for improving their situation (a list of guiding questions is presented in the annex).

The results of the case study were used to include the perspective of the farmers in the conceptual framework and to evaluate how the extensions to the research framework presented in chapter 7 can be implemented. This evaluation is presented in chapter 8.

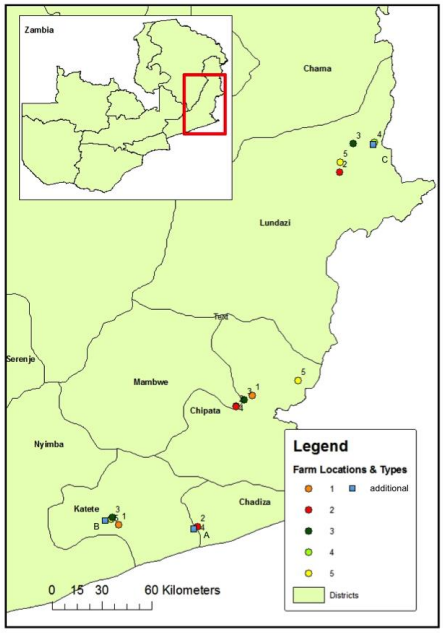

Fig. 3.2 Map of Zambia showing the location of the visited farms (adapted from M. Michalscheck, personal communication 2014)

Box 2: Case Study Location: Eastern Province of Zambia

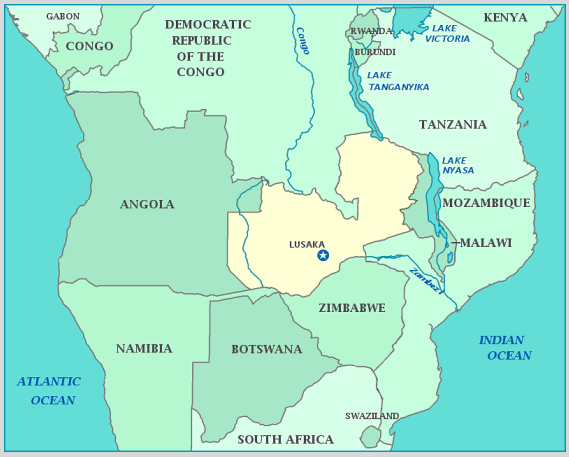

Fig. 3.3 Map of Zambia

Agriculture supports the livelihood of 70 percent of Zambia's 13 million inhabitants. Yet rural poverty remains very high at over 80% (Malapit et al. 2014). The Eastern Province is one of the poorest areas in Zambia. The majority of its population live below the US$1/day poverty line. This is also reflected by the fact that 31 % of females and 21 percent of males have no education. These are the highest ratios in national comparison Also the Infant Mortality Rate is with 97 deaths per 1000 live births clearly above the national average of 76. Moreover 49.5% of children in the region had a reduced growth rate in 2007, which points at high occurrence of permanent malnutrition (COS et al. 2009). The Eastern Province is home to only 12% of the country's population but to 23 % of the nation's female-headed households. The Province's population density is with 24 people/km^2 higher than the national average of 19, which results in comparatively lower land availability (Aregheore, n. d.). As in the whole country, inadequate infrastructure, small agricultural parcels, low productivity and seasonal variability of the climate have resulted in stagnating yields of staple crops (Malapit et al. 2014). Yet smallholders have been relatively more productive (Aregheore, n. d.). The area of the Eastern Province is a plateau with flat to gently rolling landscape on altitudes ranging from 900 to 1200m. The growing season lasts from November to April, with most of the annual rainfall of about 1000mm falling between December and March (Simukuko et al. 2007). Major agricultural activities are the cultivation of maize, groundnuts and a wide range of other crops and livestock. It is categorized as agro-ecological region II, the country's region with the highest crop potential (Siegel 2008). Due to these reasons the Eastern Province is also known as the country´s "maize basket" (Aregheore, n. d.). Based on their high potential for agricultural production and the high poverty rates, five districts of the Eastern Province- Chipata, Katete, Lundazi, Nyimba, and Petauke- were selected as an intervention site of the ‚Feed the Future Initiative' of the US government (Malapit et al.), of which the activities of Africa RISING in Chipata, Katete and Lundazi are a component.

4. Concepts of Gender in Agriculture

This chapter constitutes the first step of the conceptualisation. It presents four main concepts that were identified as crucial to describe gender relations within smallholder households based on literature review and expert interviews: the household, gender-division of labour, gender-gap in productivity and empowerment. In the following chapter 5 a variety of research methods and indicators is presented for each of these concepts. This is to evaluate which of these methods can be used in the context of farming systems analysis. The second step of the conceptualisation is the conceptual framework presented in chapter 6. It visualises and explains inter-linkages between the concepts presented in the following and sustainable intensification of farming systems.

4.1 Gender

For clarification, this section gives a definition of gender and explains related terms.

Different definitions of 'gender' generally have in common that they differentiate between gender as socially and culturally constructed and sex as a biological quality.

> "Gender refers to the socially or culturally established roles of women **and** men. Because gender is a social construct, women's and men's roles may differ from one place or culture to another and may change over time. In any particular location they need to be discovered." (Feldstein and Jiggins 1994, p.2)

> "Sex is a fact of human biology; gender is not. The experience of being male or female differs dramatically from culture to culture. The concept of gender is used by sociologists to describe all the socially given attributes, roles, activities, and responsibilities connected to being male and female in a given society. Our gender identity determines how we are perceived, and how we are expected to think and act as women and men, because of the way the society organized." (March et al. 1999, p.18)

Feldstein and Jiggins see gender as referring to the different roles of men and women. In sociology a **role** is defined as the expected behaviour associated with a certain status. A **status** can be explained as a category or position that a person holds and that is determining how he or she will be perceived and treated and which behaviour is expected. It is important to note that statuses can be acquired by achievement- through one's own efforts- or be ascribed by other people, either directly at birth or at a later point in life: One person usually has multiple statuses: A man can for instance be a father, son, researcher and patient at the

same time. He will change his behaviour according to the specific social context. While somebody might be expected to treat his parents in a very respectful way, too obedient behaviour might be considered inappropriate in professional life. This is an example of how our statuses determine the different roles that we have in society. In the performance of these roles we are guided by **social norms**, certain rules that a society shares. These norms determine the privileges and responsibilities connected to a certain status (Lindsey 2011).

In short **gender roles** can be described as follows: women and men are often ascribed different statuses (more women become nurses than men) and even if they occupy the same status, the related normative role requirement may be different (a male nurse is expected to behave differently and perform other tasks than a female nurse). Men and women interact and relate with each other on the basis of these normative role requirements. The structure of these interactions can also be called **gender relations** or **gender arrangements** (GTZ and BMZ 2009).

The intersectionality approach (see introduction) has highlighted that people may face multiple oppressions based on the many statuses they hold not only regarding their gender, but also because of their race, class or sexuality. The expectations also differ depending on how those statuses are combined- how they intersect. A white woman's s behaviour is judged differently than that of a black woman. Moreover it is stressed that the concepts- gender, race, ethnicity- are not a static attribute but emerge and continue to change in a socially constructed process (Lindsey, 2011; B. Bock, personal communication, August 2014).

To conclude, gender is a social-cultural construct that differs in time and place and from culture to culture. Based on Judith Butler (1990), gender differences manifest themselves in three levels of society: social institutions, social norms and personal identity. Social norms were described above. **Social institutions** are complex organising forms such as governments, the family, human languages, universities, hospitals, business corporations, or legal systems (Miller 2012). Gender identity describes how a person perceives his or her own gender and the role requirement connected to it. Gender analysis can look at all these three levels of society but this study focuses on social institutions as described in the following subsections: The household and gender division of labour in agriculture are social institutions themselves (4.2 and 4.3). The gender gap in productivity is a result of gender in institutions such as the official and traditional legal system with its implications on availability of land, or the gender division of labour that demands more labour time of women for domestic tasks (4.4). Empowerment can be described as a process that aims to

enhance women's access to power and as a result change established gender identities, norms and institutions to the benefit of those that were oppressed (4.1.5).

4.2 Household

Everybody has an understanding of household because the word is used in daily life. The 'common cooking-pot' definition generally refers to a group of people that share a home or living space, aggregate and share their incomes and regularly take meals together (Marshall 1998a).

Yet how a household is defined has always been dynamic and influenced by political, historical and cultural factors (Bentley and Fields 2003).

For instance different definitions may or may not include households of non-related people, who may have very variable limits to the extent in which they share income and expenditures (Marshall 1998a). It is also debated on the residency requirement, i.e. whether persons need to live in the same place at all or how much time per year they need to stay at the same place to be considered as household members. Standard definitions usually include common food consumption, pooling of resources or shared production decisions and the affective relations (Beaman & Dillon, 2012; B. Bock personal communication, August 2014).

4.3 Gender Division of Labour

According to UNESCO, Gender Division of Labour is „the result of how each society divides work among men and among women according to what is considered suitable or appropriate to each gender"(2003). In the context of small scale farming, the household's gender division of labour describes which agricultural and domestic tasks are normally done by men, which by women and which are done jointly.

Gender Analysis is often focused on how men and women divide productive and domestic labour among each other. **Domestic labour,** which is also called **reproductive labour**, refers to housework in most definitions but may also include emotional labour, such as tension management and caring.

The term ‚reproductive labour' stems from Marxist feminism and Friedrich Engels' distinction between productive (value creating) work and reproductive work that recreates the worker or his or her capacity to work (Marshall, 1998b).

Ray Pahl introduced the term ***household work strategy*** in his book *Divisions of Labour* (1984). It refers to the way in which household members divide tasks of different working domains among each other, either implicit or by explicit decision making. Instead of differentiating only between productive and reproductive work, he uses three categories of employment: in the **market economy**, including home-based self-employment second jobs that generate monetary income; **domestic production work**, agricultural activities within the home that supply food to the household; and **domestic consumption work** that provide goods and services within the household, such as cooking meals, child–care, household repairs, or the manufacture of clothes and gifts Marshall (1998c).

4.4 Gender Equality

The UNESCO defines **Gender Equality** as follows:

> **"**Gender Equality means that women and men have equal conditions for realizing their full human rights and for contributing to, and benefiting from, economic, social, cultural and political development. Gender equality is therefore the equal valuing by society of the similarities and the differences of men and women, and the roles they play. It is based on women and men being full partners in their home, their community and their society" (2003).

There is rising global acceptance of gender equality as an important goal of public policies. More than 185 countries are parties to the 1979 'Convention on the Elimination of All Forms against Women' (CEDAW) (UN WOMEN n. d.). The states that accepted the Convention commit themselves to incorporating the principle of equality of men and women in their legal system and undertake a series of other measures to end discrimination against women [Zambia ratified the CEDAW in 1985.] (UNTC n. d., OHCHR, n. d.). The Millennium Development Goals that were embraced by all UN Member States specifically target gender equality (UN WOMEN, n. d.). The World Bank's 2012 World Development report had the main topic of gender equality and development. It describes progress towards gender equality in the last 25 years in terms of globally more access to education for girls, higher female literacy rate and participation in the workforce, but also highlights that girls and women among vulnerable groups, those who are poor, live in remote areas, are disabled or belong to minority groups, are still disadvantaged. This can be seen in higher rates of female mortality compared to male mortality among children and people in the reproductive ages (World Bank 2011).

4.5 Empowerment

Empowerment is a multi-dimensional concept and among the many approaches to define and measure it, Kabeer's definition of 1999 is still influential (Imai 2014; Sraboni 2014). She stated that:

> "Empowerment is about the process by which those who have been denied the ability to make strategic life choices acquire such an ability" (Kabeer 1999, p. 435).

In her definition she explains "strategic life choices" to be those critical for people to live the lives they want and gives the following examples: the choice of livelihood, whether and who to marry or whether to have children. Empowerment is then defined as the increase of a person's ability to exercise these choices. According to Kabeer (1999), this ability can be investigated from three interrelated dimensions (see fig. 5.2). The first dimension relates to resources: Kabeer (1999) differentiated between material resources in the economic sense and social and human resources. This categorization can be related to the sustainable livelihood framework: Material resources referring to financial, manufactured and natural capital and social and human resources being equal to social and human capital (see section 4.1.4). Whereas the existence of material resources is a prerequisite to making choices in terms of available options, human and social resources can help to enhance a person's ability to exercise choices (e.g. education and acquired skills enhance options for earning an income, social networks can help to acquire necessary information or support for decision making). The degree to which a person can access resources also reflects the socio-cultural as well as the formal legal rules and norms that govern their distribution. The second dimension is agency, which was defined by Kabeer (1999, p. 438) as "the ability to define one's goals and act upon them" and is expressed in the person's influence in decision making, but also in his or her intellectual abilities, e.g. in bargaining, negotiating, defending one's view against conflicting goals and reflecting on and analysing one's own situation. The third dimension is achievements in terms of well-being outcomes. According to Diener (1984) well-being can be divided in physical and subjective wellbeing, the former referring to a person's health status which is dependent on the fulfilment of basic needs, such as nutrition, housing etc., the latter to a person's perceived quality of life, which can be influenced by many factors not only the person's wealth.

Kabeer's (1999) framework is only one of many definitions of empowerment, but these definitions have certain common elements: Most definitions of empowerment contain an element of process –opposed to seeing empowerment as a static state of being (e.g. O'Brien and Whitmore 1989). Kabeer explained this "processual understanding" of empowerment as follows: People with great freedom of choice might be powerful, but needn't be "empowered" if they never in their lives were restricted in their ability to make choices (="disempowered") (Kabeer 1999, p.437).

Many definitions also focus on people's ability, e.g. the ability to take choices (Malhotra, Schuler, & Boender, 2002) achieve influence (O'Brien and Whitmore 1989), or to access critical resources (Duflo 2012).

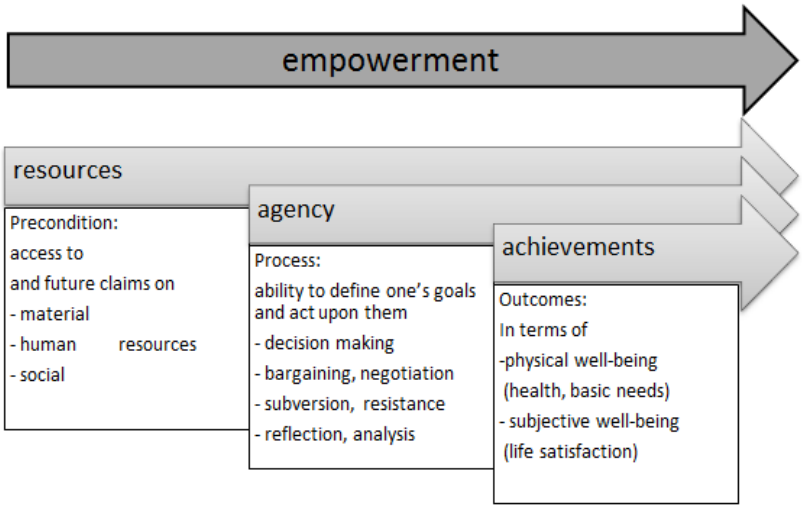

Fig. 4.2 Three interrelated dimensions of empowerment
(own illustration based on Kabeer 1999, Diener 1984)

5. Indicators and Measurements for the Identified Concepts

This chapter presents different approaches to analyse the concepts household, gender division of labour, gender equality and empowerment as defined above. They were selected based on a literature review and the expert interviews. At the end of each subchapter an evaluation is given, that presents the experts opinion on the usefulness of the different approaches for farming systems analysis.

5.1 Analysis of Household Expenditure and Division of Labour

This subchapter presents the advantages and disadvantages of using unitary and non-unitary household models in economics. Then a typology that differentiates between different household structures is presented and finally an evaluation of the different approaches.

5.1.1 Unitary vs. Non –Unitary Household models

Unitary household model

Households constitute a common unit of analysis in many sciences. In Economics, commonly a unitary model of household is used. This means that it is assumed that individuals living in one household have the common goal of increasing the household's welfare and agree on the optimal combination of time, goods purchased and goods produced to achieve this goal. The advantage of this approach is its simplicity that allows addressing a diversity of issues - such as determinants of education, health or crop adoption - with a single preference function describing household wealth (Quisumbing 2003). Yet since the 1980's the unitary model has been subject to many critiques. It has been blamed for neglecting the different rights, responsibilities and resources that household members have. Besides the assumption of altruism also conflict should be incorporated into household models to allow realistic predictions of individual behaviour (Haddad et al. 1997, Quisumbing 2003; P. Teherani-Krönner, A. Tegbaru, personal communication April/May 2014). In response to this criticism several alternative models were developed that employ a non-unitary description of household decision making, i.e. that each household member is assumed to have individual preferences

Non-unitary household models

The variety of alternative approaches can be broadly categorized in cooperative (collective) and non-cooperative (strategic) models. The former are based on the hypothesis that

individuals enter a household by free choice and thus because they expect that a household offers them advantages above being single. These advantages (in economic terms surpluses) are distributed according to certain rules that are subject to the household's bargaining process. Collective models generally assume individuals to act with Pareto-efficient outcomes, i.e. that they act so that it is impossible to increase the welfare of one household member without reducing the welfare of any other member. Non-cooperative or strategic models do not always produce Pareto-efficient outcomes. Here, each individual within a household is believed to maximize his or her own utility, constrained by individual budgets and taking the actions of other household members as given (Quisumbing 2003, Chiappori & Donni 2009).

5.1.2 Typology based on household structure

Despite looking at different ways to calculate household decision making it is also possible to try to distinguish between a variety of different household organisation forms. A recent IFPRI Paper proposed the introduction of a typology for farming households in Sub-Saharan Africa. It differentiates between: male managed; female managed, jointly managed and separately managed farming systems. Male managed refers to households, in which a male household head is dominant in every field of decision making, female managed to farms that are either de jure headed by women (widows, single or divorced women) or de facto, as men are working outside agriculture or are living in town apart from their family. Jointly and separately managed refers to two different ways of household structures in which both husband and wife are present. Either they share decision making and labour among all fields of agricultural activity or they have separated their responsibilities between different domains (e.g. between cash crop field- subsistence house garden or between animal care and cropping). Mapping of the dominant household structure of a region is hoped to inform researchers and development workers about the gendered aspects of farming and allow them to target the appropriate decision makers (Meinzen-Dick et al. 2012).

5.1.3 Measurements of Gender Division of Labour

Many studies exist that looked at how specific tasks are divided among men and women (K. Kingma, personal communication 19.05.2014) A survey or focus group discussions can be used to get data on the normative division of tasks and how the actual division differs from it: e.g. women might be generally expected to collect water, but boys or men may also collect it on certain occasions.

Seasonal Calendar

A seasonal calendar is a tool developed in the Participatory Rural Appraisal approach (PRA). It is a visual method of showing the distribution of seasonally varying phenomena in general and agricultural activities in particular (The World Bank n. d.). In case of labour calendars, it captures how the respondents perceive their labour burdens throughout the year in a qualitative way. Above assessing the mere division of tasks, this tool can thus be used to show seasonal labour peaks that might differ for men and women.

Time Allocation

Recall diaries can be used to gather information on the time men and women generally spend on each activity. A 24 hour wheel can be used to visualize a person's daily time allocation. Decisions must be taken whether to ask for the time allocation of one specific day or a weekly or monthly average (Westendorp, personal communication, May 20th 2014). Surveys and group discussion have to rely on the respondents' recollection of the time they spend on each activity. Observation is an alternative to get more objective and accurate data, but is of course a very time consuming and expensive method. Levine et al. (2001) presented a study on female and male time allocation in three different regions of the Ivory Coast. They had trained enumerators to observe 1787 women and 1565 men over 7 days, who noted every 15 min. which of 200 defined activities the persons were doing. Their results showed that the work burden of women exceeded that of men by 2.9 hours per day (Levine et al., 2001). An alternative is to combine different methods: seasonal calendar with recall diaries or survey based information with observation.

5.1.4 Evaluation

It can be argued that much of the shortcomings of the unitary household model stems from the bias of Western researchers who assumed that the structure of household they experienced themselves is valid also in other countries (A. Tegbaru, personal communication, May 7th 2014). The assumption that the meaning of "household" seems to

be common knowledge increases the risk of bringing the bias of one's own cultural background into research. Having a stereotype of a household with a nuclear family and that pools their resources in mind can make blind for the diversity of other household structures as depicted in Fig. 5.1.

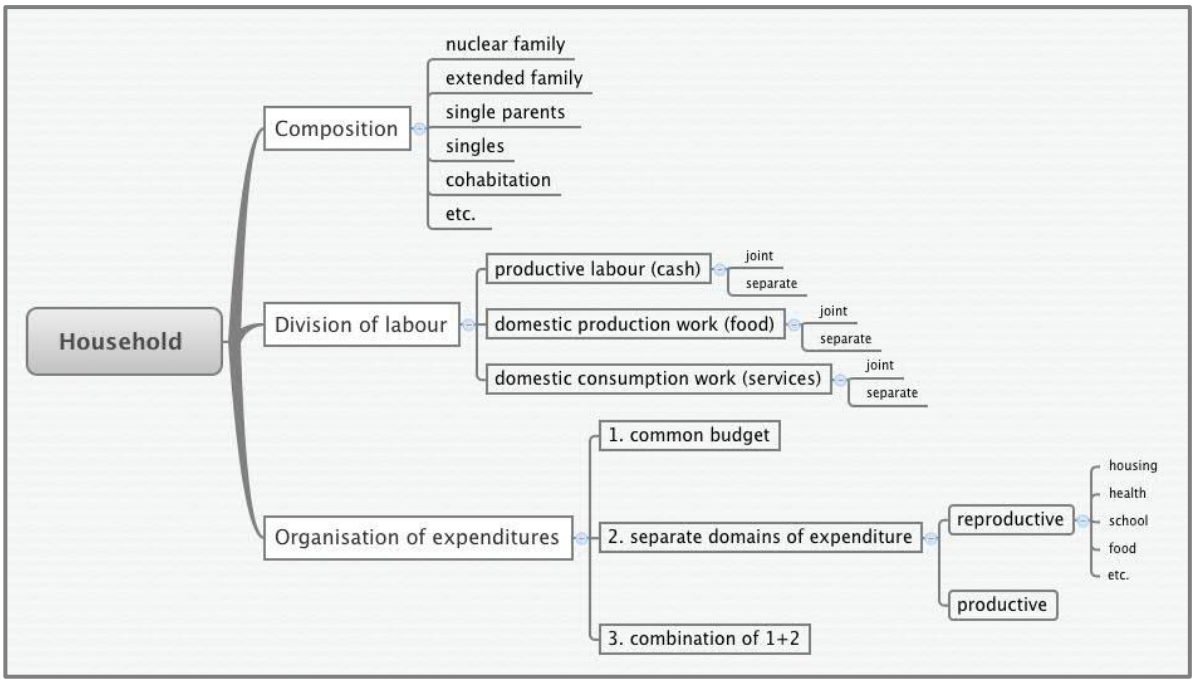

Fig. 5.1 Variety of household structures

Households differ in terms of the people who live in them, their relation to each other, their age, their position and so on. Households also vary in the way they organize the division of labour and expenditure responsibilities. In each household, different kinds of activities sustain the livelihood of household members. From an anthropological point of view the division of these tasks between the genders can be seen as a possible way to increase the efficiency of livelihood sustaining strategies via cooperation (Kuhn and Stiner 2006). Pahl categorised the different tasks that household members have to perform in employment or participation in the market economy that generates monetary income; domestic production work, that generates food for household consumption and domestic consumption work that provides services necessary within the household (section 4.3). Household members can share these tasks among each other in various ways. In many farms in Sub-Saharan Africa it is not uncommon that men and women farm their own plots separately without pooling resources (Quisumbing 2003, Chapter 7). Often men are then more involved in cash crop production (productive labour) whereas women are more engaged in the cultivation of subsistence crops (domestic production work). Common is also that agricultural production

is divided to the extent that men cultivate the main staple crop and women manage a separate plot for the cultivation of vegetables that complete the family's meal (K. Kingma, P. Teherani-Krönner, personal communication May 19th 2014/April 30th 2014). Next to farming systems in which plots are managed separately and different household members are solely responsible to take care of certain animal types, systems in which household members do all productive and domestic production tasks together also exist. Of course households may also practise a combination of the two management types, e.g. one household member could be solely responsible for small ruminants but fields are managed jointly. There is also a lot of variation in the extent that household tasks are shared among household members (domestic consumption work).

Concerning the organisation of household expenditure two broad categories can be distinguished irrespective of the gender relations of the household members. This is based on the typology by Meinzen-Dick et al. (2012) that differentiated between joint and separate management. In cases of joint management of expenditure, every individual will contribute his or her income to a common budget. Household expenses will then be paid for by this common budget. This form of management might be more common in Western societies. E.g. in households with two or more income earners, theses income earners commonly share costs for rent food and other household needs equally. Another category of households are those in which expenses are met separately. Rather than pooling all resources right from the start, household members are supposed to pay for specific expenses. E.g. one household member may use the income from vegetable production to buy household needs, while another household member may use the income from cash crop production for maintenance of the family home.

The division of expenditure domains might be linked to the division of labour. E.g. the woman who grows subsistence crops might also be responsible to buy other food for the family. Yet this is not necessarily so. E.g. the division of labour might be strictly separated while all income is pooled and decided on together.

To summarize, households vary to a large extent in their composition, division of labour and organization of expenditures due to differences in the socio- cultural and institutional context but also due to individual preferences. Generally the different strategies employed all serve the common goal of sustaining the household's livelihood.

This has implications for the decision on which household model should be used for economic or agronomic analysis. Empirical work that tested the predictions of the

cooperative non-unitary model against those of a non-cooperative model found the cooperative model to be confirmed in most settings with exceptions most notably in subsistence agriculture in Africa (Rode 2011). This is likely to be attributed to the rather strict separation of expenditure practiced there.

Farming Systems Analysis in the context of subsistence agriculture often sets the household equal with the farm business (H. Kirscht, personal communication, May 8th 2014) and bases its economic analysis on the unitary household model. As described above this can be suitable for some household types but should be rejected for others. In the opinion of Kirscht the development of a model that can differentiate between several "subcontractors" within one farming household would be a big success. Teherani-Krönner (personal communication, April 30th 2014) pointed at animal husbandry as an example of independent business domains managed by women. Rietveld (personal communication, April 29th 2014) suggested the inclusion of an extra variable for each plot that captures whether it is managed by men or women. Apart from getting insight in the efficiency of input distribution, this would also allow to analyse how men and women use their harvests in terms of marketing or household consumption. To assess management responsibility of different plots, it is important to distinguish between ownership and actual management, as men often officially own land, but women might still have land use rights and cultivate the plot independently (H. Kirscht, personal communication, 08.05.2014).

5.2 Gender Analysis Framework by Moser

This section presents a framework for gender analysis developed by Moser (1993) and evaluates how it can be applied in farming systems analysis.

5.2.1 Strategic and practical gender needs

In her Gender Analysis Framework, Moser differentiates between strategic and practical gender needs. She argues that women and men have different needs because of their different roles. She applies another categorisation of labour as presented above. Besides productive and reproductive labour, she also includes community- managing activities- such as organising weddings or funerals- and community politics activities. Whereas men are mainly involved in productive and community politics activities, women are responsible for reproductive, productive, and community managing activities, (Moser 1993). Women's responsibility for these three types of activities is often referred to as the 'triple burden of

women', to highlight the fact that women do not only have to combine work and family care but also a variety of community tasks.

Practical gender needs derive from women's and men's current working domains. If women are responsible for dairy production, they might be in need of a training to reduce storage losses, while men being responsible for construction might be in need of building material. The fulfilment of these needs, however, does not influence established social norms and institutions regarding the gender division of labour.

According to Moser (1993) **strategic gender needs** derive from women's subordinate social position. Meeting those needs has the goal to enable women to transform imbalances of power between men and women. Strategic gender needs vary according to the context. Examples can be achieving access to education, obtaining legal rights or being protected from domestic violence. Analysing the different practical and strategic gender needs can identify policy options.

5.2.2 Evaluation

According to Kingma (personal communication, 19.05.2014) it is important to go beyond the mere description of division of tasks and analyse the consequences men and women having different working domains. She stated that the assessment of practical and strategic gender needs is a valuable tool for this purpose Tegbaru stressed the importance of acknowledging the complementarity of women's and men's needs. While their responsibilities and needs are separate, they still serve a common goal of sustaining the households' livelihood and often responsibilities and tasks are divided in such a way that women's work complements men's work.

Teherani-Krönner (personal communication, 30.04.2014) pointed at the importance of linking the assessment of labour division and time allocation to women's and men's use of technology. She argues that most societies had originally lived in a balance of labour distribution between men and women. Only outside influence from colonisation and later development initiatives had destroyed this balance by unequally investing in and propagating technology for the working domains of men. E.g. much emphasis has been put on increasing productivity of cash crop production while women's production of subsistence crops was neglected. Teherani-Krönner referred to the „old thesis" of Esther Boserup, that in her opinion unfortunately still holds true: Boserup (1982) argued that gender division of labour is not "natural" and that the assumption of men working in the fields and women

being only responsible for childcare and food preparation is a bias affected by western culture. Resulting from this oversight many agricultural development programmes addressed only men and only men profited from new technology while women's labour productivity relatively declined which was connected also with a decreasing social status (Boserup, 1982). In the opinion of Teherani-Krönner (personal communication, April 30th 2014) it should be an objective of agricultural development to restore the original balance in gender division of labour by investing in technology that increases the productivity of women's' working domains. Westendorp (personal communication, May 20th 2014) stressed that it is not about „bringing the men in the kitchen or women ploughing" but to know about the different interests that women and men have and design interventions accordingly (in Moser's terms meet women's' and men's' practical gender needs). She advised to consider qualitative as well as quantitative aspects of labour. Labour saving technologies were often not adopted because women preferred to do their tasks the traditional way if this was a more enjoyable social activity.

Also Kingma (personal communication, May 19th 2015) pointed out that it is not enough to look whether labour time is available for a proposed intervention. One should rather evaluate if the intervention provides an incentive that people will like to invest their time for as „availability has a lot to do with priority".

To summarize, the tools to assess gender division of labour and the associated differences in labour burdens- seasonal calendars or other methods that measure time allocation- are a prerequisite for agricultural intervention. Ignoring women's contribution to agriculture and their labour burden in domestic tasks can prevent the adoption of new technologies and or women being comparatively disadvantaged. Yet a necessary next step should be to analyse the implications of labour division for women's and men's practical and strategic gender needs. This would facilitate agricultural research to design interventions that target the specific constraints of male and female farmers.

5.3 Measures for Gender Inequality

As in the preceding sections, the following part will first describe methods to evaluate gender inequality and consequently evaluate their usefulness for farming systems analysis.

5.3.1 Gender Gaps in Access to Resources

As described above gender inequality is often captured by looking at the differences in how men and women can fulfil their human rights or access critical resources such as education or health services. One way to categorize these resources is livelihood capital. This is a component of the sustainable livelihood framework and differentiates between five types of capital: human, social, natural, physical and financial (Scoones 1998).

Natural capital (also environmental or ecological capital) refers to natural resources (energy and matter) and processes that are needed to sustain a livelihood (Forum for the Future n. d.). In the context of small scale farming households the land needed for agricultural production, water for production and for household needs or fossil fuels or timber for cooking, but also processes as climate regulation or the carbon cycle are examples of natural capital. **Human capital** includes the health, knowledge, skills, intellectual outputs, motivation and capacity for relationships of the individual, but also joy, passion, empathy and spirituality (Forum for the Future n. d.). The term **social capital** has been used for a range of phenomena (Bruce and Yearly 2006). Common elements of the different definitions are trust, community networks, shared values or a degree of communal responsibility and reciprocity (de Vaus 2013). In the context of Farming Systems Analysis, social capital can be seen as the networks and social relations that enable people to act for mutual benefit (based on a definition by Stone (2001, p.4) Social capital can be very gendered as often separate men's and women's networks exist (B. Bock, personal communication, August 9th 2014). **Physical or manufactured capital** refers to the material goods and infrastructure that can be owned, leased or controlled and is used for production and service provision, but not a product of production. This includes buildings, infrastructure and technologies (Forum for the Future, n. d.) **Financial capital** includes available owned money and access to credits. (Forum for the Future, n. d.)

Gender Gaps

To get information about gender equality, the different access of men and women to each of the five capitals can be measured. The difference in male and female achievement is then commonly called the gender gap. Different frameworks need to be used for each of the five

capitals; especially social capital can be complex in its assessment as described by Stone (2001).

5.3.2 Gender Gap in Agricultural Productivity

Since the publication of the FAO State of Food and Agriculture 2010–2011 report: „Women in Agriculture-Closing the gender gap for development“ much attention has been given to differences in male and female agricultural productivity. The report had presented that women in developing countries were disadvantaged in their access to agricultural resources, education, extension, financial services and labour markets. The report reviewed 27 studies on the difference of productivity of plots cultivated by men and women. These were performed in a wide range of countries but primarily in Africa. This is due the fact that only in Africa systems exist where women cultivate their independent plots with the same crops as men. All other studies had to rely on the difference of productivity between male and female- headed households. The studies assessed productivity in a variety of methods, but primarily yield or output per hectare of land was used as indicator for production. Based on the findings on yield difference between male and female plots, the FAO calculated that women could increase yields by 20 to 30 per cent, if they had the same access to resources as men. Depending on the share of land managed by women, this could raise total agricultural output in developing countries by 2.5-4% (FAO 2011).

5.3.3 Evaluation

As explained by Rietveld (personal communication, April 29th 2014), the gender gap in agricultural productivity is currently the most debated topic in literature on gender and agriculture. When looking at reasons why women don’t get the same returns from land as men do, it is often pointed at women’s lacking opportunities for land ownership. Mulema (personal communication, May 23rd 2014) explained that women whose land use rights are uncertain in duration might hesitate to invest in soil conserving measures. But Rietveld (personal communication, April 29th 2014) suggested that land ownership is only one of the underlying causes for a productivity gap. While women may indeed be assigned to cultivate less fertile land their labour time for their own plots might also be constrained. Their total working time might be restricted due to domestic work and they might be obliged to work on their husbands’ fields first. As a consequence women can only work on their own plots at a later stage of the agricultural season, which leads to a delay in sowing dates or weeding

with potentially large effects on the crop's yield. In accordance with the FAO report, Rietveld (personal communication, April 29th 2014) also suggested that women had less access to credit for fertilizer or seeds, less knowledge and less access to extension, which also contributes to lower yields.

Kirscht (personal communication, May 8th 2014) highlighted the need to differentiate between production as the total amount of harvest and productivity that can be measured based on different criteria e.g. productivity of labour or productivity of inputs used. As highlighted by Teherani-Krönner (personal communication, April 30th 2014), it is pointless to argue that women's labour productivity might be different from men's. Of course women and men would produce the same amount if they had the same inputs; one could even argue that women would produce even more. Yet Teherani-Krönner criticises the FAO approach, because current methods of production are not questioned: Why should it be an objective that women cultivate their fields the same way as men, if the conventionally advocated methods have led to severe problems (such as soil degradation or small farmers being in debt to seed companies, loss of biodiversity etc.)?

The conclusions of the FAO can also be criticised from a methodological point of view, because they combine data from studies that looked at the difference in productivity of male and female-headed households and those that looked at productivity differences between male and female managed plots within one household. One of the studies cited in the FAO report that looks at productivity differences within the family farm is by Alderman et al. (2003). In the context of Burkina Faso- in which different members of the family cultivate the same crop on different plots- they found that plots controlled by women produced lower yields than those controlled by men. It was calculated that six percent more output could be reached if inputs were redistributed within a household (Alderman et al., 2003). Yet this conclusion ignores the possibility of women having other activities in which they performed or allocated better (J. Groot, personal communication, August 2014)

Rietveld criticised the comparison of productivity between male and female-headed households (personal communication, April 29th 2014) she suggested that differences that are found there are not only due to gender differences. As female-headed households normally are one-parent households they are biased because of more reasons than just the gender of the household head. Moreover the majority of women normally live in male-headed households and analysing only female-headed households does not provide information on their situation. As mentioned in section 5.1.4 Rietveld (personal

communication, April 29th 2014) suggested that farming systems analysis should assess whether a woman or a man manages a plot. This could be used to evaluate the difference in production and indicate areas where women are disadvantaged. Another alternative to current research methods would be to equally involve male and female respondents in household surveys. To do this, there would be no need to survey male and female respondents for every household as this would double labour and costs of research. Rather an equal amount of men and women could be surveyed among all households. While this does not allow evaluation of productivity differences, it could ensure that the specific constraints and needs of female farmers are considered and allow for conclusions about different views on agriculture among male and female farmers.

When the gender gap in agricultural productivity is discussed, the conclusion is often to enhance women's access to resources to increase overall production and food security. This can be criticised because of two main reasons: firstly evidence is lacking that the productivity gap is caused by unequal access to resources only and that women's limited labour availability and different priorities are not more influential. Secondly women are seen in an instrumental way as to reach food security and less attention is paid to their right to gender equality.

5.4 Empowerment Indices

The following section first presents the Gender Empowerment Measure and the Gender Inequality Index of the UNDP and then the Women's Empowerment in Agriculture Index (WEAI) developed in 2012 by the United States Agency for International Development, the International Food Policy Research Institute, and the Oxford Poverty and Human Development Initiative (Malapit et al. 2014). It is analysed to which extent they cover the different domains of empowerment that where identified by Kabeer: access to resources, agency as the ability to make strategic choices and achievements in terms of physical and subjective wellbeing (see section 4.5). This is to evaluate how well the indices capture the concept of empowerment. The evaluation in section 5.4.3 also describes possible application of the indices for Farming Systems Analysis.

5.4.1 UNDP Gender Empowerment Measure and Gender Inequality Index

Measurements of empowerment can be differentiated in those that compare sex-disaggregated data of national level-statistics and those that are based on household-

surveys specifically designed for that purpose. All of these measurements typically combine multiple indicators that cover to different degrees the three dimensions presented by Kabeer (see table 5.1).

Table 5.1 Overview of different indicators used to measure empowerment compiled by and cited after Imai et al. (2014) and classified according to the three dimensions of empowerment by Kabeer (1999)

Dimension of empowerment	Indicator	Reference
Resources	Inheritance and divorce laws	Agarwal, 1994; Fafchamps, Kebede, & Quisumbing, 2009; Quisumbing & Maluccio, 2003
	Assets at times of marriage	Agarwal, 1994; Fafchamps, Kebede, & Quisumbing, 2009; Quisumbing & Maluccio, 2003
	Freedom of movement	Afridi (2010)
	Social norms on marriage and divorce	Anderson & Eswaran, 2009; Rahman & Rao, 2004
	Access to money	Afridi (2010)
	Gender difference in Education, Educational attainment	Smith et al., 2003; Thomas, 1994, Afridi (2010)
Agency	Cognitive ability	Fafchamps et al. (2009)
	Decision making power	Hashemi, Schuler, and Riley (1996)
	Political and legal awareness	Hashemi, Schuler, and Riley (1996)
	Participation in public protest and political campaign	Hashemi, Schuler, and Riley (1996)
	Control over finances	Bloom, Wypij and Gupta (2001)
Achievements	Ratio of female and male life expectancy at birth	Smith & Haddad, 2002
	Violence, physical abuse	Fafchamps et al. (2009), Afridi (2010)

The UNDP has been influential in assessing and reporting on countries' development status. Since 1995 its Human Development Report includes two gender indices that are based on national level statistics: the Gender Related Human Development Index (GDI) and the Gender Empowerment Measure (GEM) (Grynspan 2011). The GDI includes indicators for life expectancy, educational attainment and income- the same components as the Human Development Index- and then compares the different achievements between men and women in these components as a measure of inequality (UNDP n. d.). The GEM combines three basic indicators as depicted in table 4.2 (Cueva Beteta 2006). These indicators were selected to represent women's political and economic participation (Grynspan 2011**).** They can be interpreted as reflecting two of the domains of empowerment. The proportion of seats held by women and of women in economic decision making positions indicates access to income (resource) and agency in terms of influence on decision making and defending

their choice to follow a career for the concerned women. **Table 5.2 Indicators of the GEM (Grynspan 2011) classified according to the three dimensions of empowerment by Kabeer (1999)**

Index	Indicator	Dimension of Empowerment
GEM	Proportion of seats held by women in national parliaments	Resource/ Agency
	Percentage of women in economic decision making positions	Resource/ Agency
	Female Share of Income	Resource

Yet next to criticism concerning its methodology of data aggregation and the use of international databases, the GEM has also been criticized for the choice of dimensions and indicators (Cueva Beteta 2006). The indicators only reflect the situation of a minority of successful women, whereas no conclusions on the empowerment status of women that are not engaged in the market economy can be made. Consequently a new measure was in introduced in the UNDP 2010 Human Development Report- the Gender Inequality Index (GII). This index combines five indicators as presented in table 4.3.

Table 5.3 Indicators of the GII (Grynspan 2011) classified according to the three dimensions of empowerment by Kabeer (1999)

Index	Indicator	Dimension of Empowerment
GII	Labour force participation	Resource/Agency
	Education attainment	Resource
	Parliamentary representation	Resource/Agency
	Adolescent fertility	Agency
	Maternal mortality	Resource/ Achievements

Compared to the GEM, the proportion of women in economic decision-making positions and the share of income were left out and substituted with the labour force participation rate. Three additional indicators were added: Education attainment as an indicator that allows conclusion on women's and men's access to human capital (Resource); Adolescent fertility, a proxy for the use of contraceptives and thus the ability to decide whether to have children or not (Agency); and Maternal mortality as an indicator for women's access to health services and physical wellbeing. The GII value reflects the percentage of loss in achievement that can be attributed to gender inequality. E.g. in 2012 the world average GII was 0.46, which reflects a loss of 46%. Among 148 ranked countries, the Netherlands had the lowest GII with 0.045. Zambia was on rank 136 with a value of 0.623.

5.4.2 Women's Empowerment in Agriculture Index

The Women's Empowerment in Agriculture Index (WEAI) is a survey-based index that collects information from both, female-headed and male-headed households. It is calculated by combining two sub-indexes: the five domains of empowerment index and the gender parity index. The first sub-index—the five domains of empowerment (5DE) index—measures empowerment based on 10 indicators in five domains: Production, Resources, Income, Leadership and Time as presented in Table 4.4. The table was extended with a categorization into the dimensions of empowerment in Kabeer's (1999) framework and it can be seen that the WEAI focuses on the agency dimension.

The second index of the WEAI- the gender parity index (GPI) - compares the results for the 5DE index of women and men in the same households. A woman is considered to have gender parity if her results in the five domains of empowerment are at least as high as those of an adult male in the same household. Consequently the GPI cannot be calculated for women living in households without adult males. The GPI combines the percentage of women who have achieved gender parity with the average gap between male and female performance in households with gender disparity (Malapit et al. 2014). Box 3 gives an overview of the WEAI data collected for Zambia that were collected in 2012 and will be further discussed in Chapter 8.

Table 4.4: The five domains of empowerment in the WEAI

Domain	Indicators	Description	Weight	Dimension of Empowerment
Production	Input in productive decisions	Sole or joint decision making over food and cash-crop farming, livestock and fisheries	1/10	Agency
	Autonomy in production	Summarizes answers on the extent to which the individual feels he or she can make his or her own personal decisions about household life: about the inputs to buy, types of crops to grow and to sell and whether to engage in livestock raising	1/10	Agency
Resources	Ownership of assets	Sole or joint ownership of major household assets (including agricultural land, large and small livestock, fish ponds, farm equipment, house, household durables, cell phone, non-agricultural land, and means of transportation)	1/15	Resources
	Purchase, sale, or transfer of assets	Whether respondent participates in decision to buy, sell, or transfer his/her owned assets	1/15	Agency
	Access to and decisions on credit	Access to and participation in decision making concerning credit	1/15	Resources, Agency
Income	Control over use of income	Sole or joint control over income and expenditures	1/5	Agency
Leadership	Group member	Whether respondent is an active member in at least one economic or social group (e.g., agricultural marketing, credit, water users' groups)	1/10	Agency
	Speaking in public	Whether the respondent is comfortable speaking in public concerning various issues such as intervening in a family dispute, ensure proper payment of wages for public work programs, etc.	1/10	Agency
Time	Workload	Allocation of time to productive and domestic tasks	1/10	Resources
	Leisure	Satisfaction with the available time for leisure activities	1/10	Achievements

Source: extended from Sraboni et al. (2014) & Alkire et al. (2013).

Box 3: WEAI-results for the Eastern province of Zambia

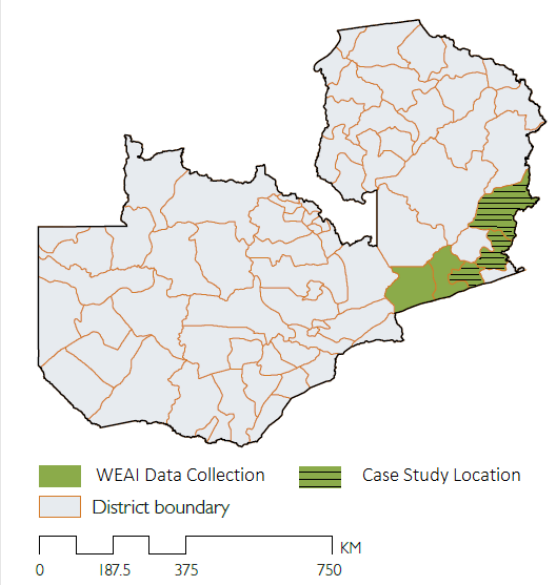

Fig. 5.2 Map of Zambia showing area of WEAI Data Collection and case study area (modified from Malapit et al. 2014, p. 32)

Zambia's baseline WEAI score:	0.80
5DE score index: 0.79	
GPI score index: 0.89	
Key constraints for women: Workload, access to and decisions on credit, speaking in public	

Fig. 5.3 WEAI scores for Zambia and key constraints for women identified (Malapit et al. 2014, p. 32)

The data for the WEAI were collected in 2012 among 1,640 households in five districts as illustrated in fig. 5.2. The case study area lies within this region. The WEAI score for Zambia is 0.80. This value is a combination of the 5DE score and the GPI score. The 5DE score of 0.79 indicates that approximately 40 percent of women have achieved adequate empowerment. Those who are not yet empowered (about 60 percent) have a mean 5DE score of 0.64. The GPI of 0.89 indicates that 45.94 percent of the women in the survey have achieved gender parity and for women without gender parity the average empowerment gap is 0.20 compared to adult males in their household.

Fig. 5.4 reveals the different performance of men and women in the 10 indicators of empowerment. It can be seen that the indicators workload, access to and decisions on credit and speaking in public contribute most to women's disempowerment. Based on this, these domains were identified as key constraints to women by the authors of the WEAI report (fig. 5.3).

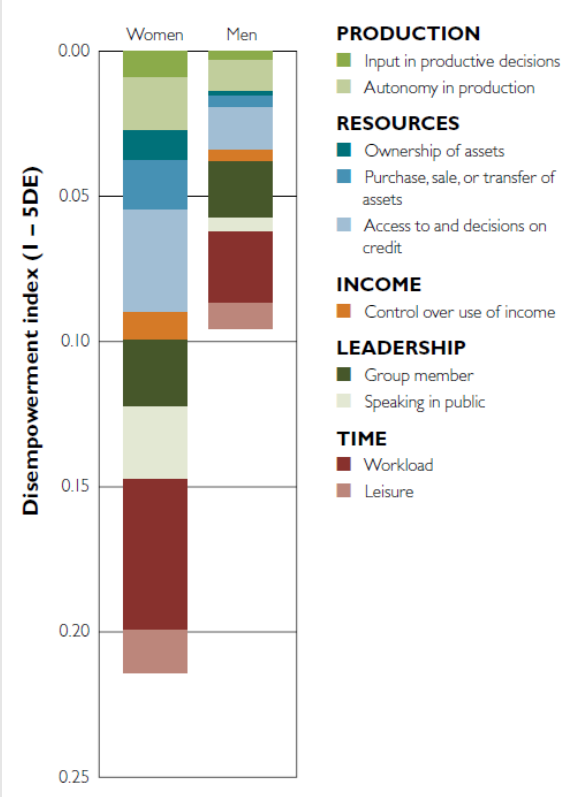

Fig. 5.4 Contribution of different indicators to women's and men's 5DE score in the WEAI (Malapit et al. 2014, p.33)

The WEAI report summarizes findings from 13 countries: Bangladesh, Cambodia, Nepal, Tajikistan, Haiti, Honduras, Kenya, Rwanda, Uganda Ghana, Liberia, Malawi and Zambia. In cross-country comparison Zambia was ranked medium. It could also be shown that there is a strong positive relationship between female empowerment measured in the WEAI and the prevalence of children receiving a minimum acceptable diet- a composite indicator of minimum dietary diversity and minimum meal frequency. Also the rates of exclusive breastfeeding for children under six months were positively correlated to the WEAI score. Zambia together with Haiti had the lowest rates of exclusive breastfeeding among the 13 countries. Nevertheless the relationships between child nutritional outcomes and women's empowerment were unclear, which could be attributed to the fact that child nutritional status is also affected by access to health care and sanitation, whereas frequency of meals, dietary diversity and length of breastfeeding is directly linked to the mother's behaviour. (Malapit et al. 2014)

5.4.3 Evaluation

Measurements of empowerment in general have the problem of finding a universally valid definition. As Kabeer puts it:

> "As far as empowerment is concerned, we are interested in possible inequalities in people's capacity to make choices rather than in differences in the choices they make" (1999, p.439)

The GEM and GII measure women' s participation in the economic labour force and assume that equal participation/ equal income between genders would be a sign of gender equality and thus empowerment. Syed (2010, p. 238) criticises this focus on participation in the market economy. He argues that gender research is biased by "Eurocentric paradigms" and characterised by "secular and capitalist ideologies", as it is only due to the capitalist view that domestic labour was defined as non-productive and therefore devalued. In his opinion unpaid economic activities need to be accounted for in analysis and given the same value as paid activities (Syed, 2010). Pearson (2004) argued in the same line when criticizing the "Engelian myth" [named after and based on ideas by the German political theorist Friedrich Engels]: this view holds that women's empowerment can only be achieved by equal participation in the paid workforce. It is especially difficult to capture a person's achievement in terms of subjective wellbeing. Whereas physical wellbeing, i.e. the person's health and nutritional status, can be easily measured, it is difficult to conclude from a person's position

in the society on his or her life satisfaction. Often the definition of what is defined as an achievement is already biased by the researchers values (Kabeer 1999) and also allows for very different interpretations. For instance one could interpret achievements strictly as the person's subjective wellbeing, or assume that reaching certain educational degrees or job positions is a higher achievement than to concentrate on domestic work.

The WEAI is one possible way of using quantitative indicators while at the same time focusing more on women's agency, a dimension of empowerment that has been studied far less than resources or achievements until now (Sraboni et al. 2014). The baseline-report on the WEAI points at several possible applications of the Index. Originally designed as a monitoring tool to measure the impact of interventions by the ´Feed the Future' initiative by the US government, the WEAI could also serve as a diagnostic tool. It could be used to identify the domains in which women and men in a certain geographic region are particularly disempowered, and to design and target future interventions accordingly. The authors also pointed at the potential of the WEAI as a research tool and suggest the exploration of linkages between the WEAI and other household outcomes. They also see the need to test the WEAI's validity across different countries and whether different indicators for the five empowerment domains could be used. But the authors also acknowledged limitations of the WEAI: firstly, that it may not be representative of all adult women in a region because only one woman was interviewed per household: respondents may be more empowered than other women in the household because they were the first decision makers next to their male counterparts. Secondly, women in female-headed households are likely to be classified as empowered in the WEAI, because the index focusses on the share in decision-making. Moreover, the index looks solely at empowerment in agriculture and empowerment in other domains might be overlooked. E.g. decision making was only assessed regarding agricultural production despite the fact that participation in other fields of household decision making could be more relevant for specific desired household outcomes, e.g. nutrition (Malapit et al. 2014).

Interview results confirmed that the WEAI has potential to be used in many ways (A. Rietveld, personal communication, April 29th 2014) yet also pointed at some limitations: Teherani-Krönner (personal communication, April 30th 2014) questioned whether leadership in public groups could allow for any conclusions about a woman's position within her household. A woman could be very active in a community group, but still have a low status and no part in decision making in the relation to her husband. In general collecting data

about intra household decision making would require careful triangulation as people would first answer according to the social norm and be reluctant to tell about what their family practices in reality (the social norm might be that husband and wife make decisions together whereas in reality the wife has no say, or also a social norm could be that men are principal decision makers in the family and women might then be reluctant to tell about how independently they manage certain fields of the farm) (A. Rietveld, P. Teherani-Krönner, personal communication, April 29th/30th 2014). Another point is that people might be unaware of a general pattern of decision making, and information could be better obtained by asking questions about specific situations- e.g. who decided yesterday? (B. Bock, personal communication, August 2014) Teherani-Krönner (personal communication, April 30th 2014) also criticized that labour allocation was not analysed in relation to the equipment used. Rietveld (personal communication, April 29th 2014) pointed at the complexity of the index that would require strict fulfilment of a standard research methodology, which is time-consuming and difficult to assess. Yet she suggested that it could be possible to use available WEAI data and then try to collect complimentary farm household data.

To conclude, despite their limitations the GDI and GEM are a first source to get an indication to which extent gender discrimination is a problem in the country or region of interest (Grynspan 2011). The WEAI is valuable as diagnostic tools that identifies in which domains of agriculture women and men are particularly are disempowered and which of these domains should be consequently targeted by interventions. Moreover it can reveal topics for more in depth research on differences in empowerment in certain regions and how this relates to different farming styles or also agricultural productivity.

6. Conceptual Framework Analysis

The Conceptual Framework Analysis presented in the following aims to provide understanding of gender relations in small scale-farming households and of the ways they are affected by measures for sustainable intensification of agriculture. The first step in building this conceptual framework was to identify relevant gender concepts as described in chapter 4. The next step will be to explain the relation of these concepts to each other in section 6.1. Section 6.2 describes different approaches to Sustainable Intensification. The two first sections form the basis for section 6.3 in which a conceptual framework is presented that shows the interlinkages between the gender concepts and sustainable intensification. The conceptual framework hopes to provide understanding why agricultural research activities should be adapted or extended to become more gender – sensitive.

The presented conceptual framework is valid to explain dynamics between agricultural intensification and household gender relations that are similar in many countries of the South. Yet it is focused on the Africa RISING program and its implementation in the Eastern province of Zambia to illustrate the problems at hand with concrete examples. According to the methodology of model development by Bontkes (1999), the conceptualisation serves to define the structure of the problem that is to be analysed with the model. The objective of Africa RISING is as follows:

> "The Africa RISING program seeks to provide pathways out of hunger and poverty for smallholder families, and especially women and children, through the process of sustainable intensification. This involves producing more crops and livestock from the same piece of land, without degrading the natural resource base, thus generating more food and higher incomes (Africa RISING, n. d.)."

The problem at hand is thus poverty and hunger among smallholder families. The objective is to raise agricultural productivity with the purpose of better nutrition of all family members and a rise in total household income. The constraint is to conserve the natural resource base. The gender perspective can be integrated in model-based farming systems analysis following two different approaches: the first option is to see gender equality as an additional constraint. Productivity should be increased up to the point in which further interventions would decrease gender equality. This is coherent to the **gender responsive** approach of research that aims at research activities to be of equal benefit for women and men, and harm neither of them (see chapter 2). The second option is to see increasing gender equality as an additional objective. This is coherent to the **gender transformative** approach that

seeks to change gender relations and decrease gender inequity (IITA n. d.). Both of these approaches have their legitimisation, as will be described in the following.

6.1 The Gender Wheel

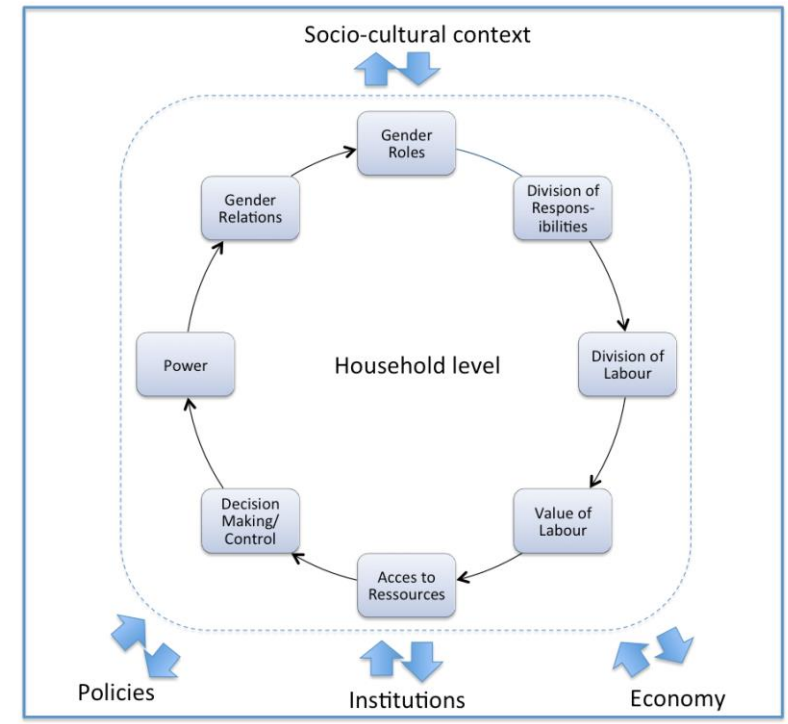

Fig. 6.1 The Gender Wheel

Figure 6.1 shows an adaptation of the gender wheel, a tool developed for training in gender awareness (Parker et al. 1995). It describes the dynamics of gender relations within households. Gender roles or societal norms influence how men and women divide responsibilities among each other. This specific division of responsibilities leads to the typical gender division of labour within a society. E.g. women are often held responsible for childcare and thus are expected to do all related work. In other societies responsibility for childcare might be divided between the genders more equally and both women and men might spend equal amount of time caring for their children. The division of labour usually is accompanied with different values that are attributed to male and female labour. In many societies women are more frequently engaged in lower paid jobs, reflecting at least a lower economic value that is attributed to their work. As the economic value attributed to labour determines income, people with less valued work will also be restricted in their access to resources. But based on a broader understanding of value, value of labour will also influence access to other forms of capital. If a person's labour is less valued his or her parents and also

the society as a whole will most likely invest less in this person's human capital. Something that is reflected in lower school attendance rates of girls in many countries. Moreover a person with lower human capital will have fewer opportunities to achieve well paid positions which points at the fact that the relations in the wheel are indeed circular. The different valuation of women and men and their workforce is also reflected in the legal system and policies, for instance when the promotion of male dominated businesses is considered more important than investing in female working domains.

Access to resources or in other terms to the five different capitals determines how well a person can defend his or her own interests in societal or family decision-making. Influence in decision-making affects how powerful a person is within the family or society, which again impacts on gender relations, i.e. how women and men interact. The practised way of how women and men treat each other again has the potential to influence societal norms about appropriate behaviour for males and females, i.e. the gender roles. Behaviour of parents will also determine how children learn their gender role. The depicted relations constitute a dynamic process that is continuously subject to change fuelled by changes in the society's culture, policies and legal system or the economy. Yet the gender identity of individuals- how they perceive their position within the family- and their agency- their ability to take choices- is a prerequisite for any change in established norms. Individual change of attitudes and behaviour will again influence the societal level.

6.2 Sustainable Intensification

According to Pretty et al., most commentators agree that agriculture worldwide needs to be intensified based on the expected population growth and the limits of available agricultural land. Agricultural intensification is conventionally understood in three different ways: firstly as an increase of yields of one specific crop per hectare, secondly as an increase in cropping intensity per unit of land and other inputs (e.g. two or more crops per growing season, or more crops with the same amount of irrigation water) and finally as change in land use towards crops that receive higher market prices (Pretty et al. 2011).

In the following the focus will be on the first two definitions, as the interest for reaching food security is on raising the productivity in terms of calories not in terms of economic value.

Different strategies can be followed to reach an increase of agricultural production per land unit. The conventional approach usually combines the use of genetically enhanced varieties with an increased use of pesticides and mineral fertilizers.

The Montpellier Panel distinguished between three different types of intensification: genetic, socio-economic and ecological. Genetic intensification aims at introducing improved livestock or crop varieties with higher yielding capacity, nutrient use efficiency, nutritional value and/ or resilience to pest or diseases. Socio-economic intensification refers to the prerequisites necessary for farmers to adopt and benefit from an innovation such as the improvements in value chain efficiency or promotion of farmer groups that facilitate marketing (Pretty et al. 2011). Moreover the family's labour allocation might be suboptimal (Timler et al. 2014). Ecological intensification refers to changing farming practices, for instance by increasing the variety of crops grown; using the beneficial effects of leguminous plants or implement soil conserving measures (The Montpellier Panel, 2013). Besides technological innovation also an optimization of resource allocation can yield higher productivity. Smallholder farms might be inefficient in the way they cycle nutrients, e.g. because of inadequate manure storage and consequent losses, or because animals are fed unbalanced. Optimization of this resource allocation would result in ecological intensification.

According to van der Ploeg et al (2013) different approaches to agricultural intensification can also be categorised based on whether they are labour-driven or technology-driven. Labour-driven intensification is characterized by steady increases in yields that are a result of high amounts of skill-full labour invested in the production. On the contrary, technology-driven intensification often implies that the amount and also the quality of labour needed is reduced (e.g. use of herbicides decreases the time necessary for weeding but also farmers skills in using crop rotations that prevent the excessive emergence of weeds). Technology driven and labour-driven intensification can be conceptualised in the terminology of the sustainable livelihoods framework as depicted in Fig. 6. 2. Technology driven-intensification depicted on the left hand side.

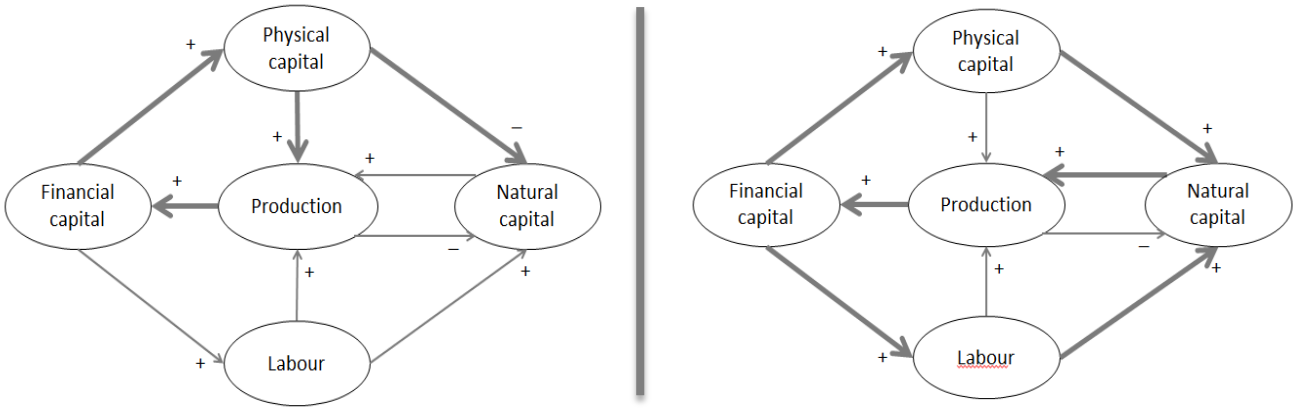

Fig. 6.2 Technology-driven vs. labour-driven intensification.

Source: J. Groot (personal communication, July 22nd 2014)

Technology-driven intensification uses high inputs of physical capital (seeds, fertilizer, machinery) to achieve a rise in production that provides the income necessary to reinvest in physical capital. This short cycle of production is often at the cost of the natural resource base (soil degradation, pollution etc.). Yet the high rates of technology employed also reduce the necessary labour inputs. Labour-driven intensification achieves a rise in productivity by increasing the quality and quantity of labour, as well as an increase in physical capital.

It can be hypothesised that technology–driven intensification with a one-sided focus on investments in physical capital can be more prone to cause continuous degradation of natural capital, whereas more sustainable production that improves natural resources requires more labour.

Yet whether agricultural intensification is sustainable or not is not measured by the type of intensification employed but by the results of the used approaches. Pretty and al. (2011, p.7) define sustainable agricultural intensification as

> "producing more output from the same area of land while reducing the negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services".

Non-sustainable production can be viewed as the opposite process. Non-sustainable changes to or existing non-sustainable farming practices decrease natural capital. This will increase the pressure on ecosystems and reduce the farm productivity. This is an incentive for farmers to again change their practices and often leads to a vicious cycle of degradation of resources, higher costs, lower productivity and increased poverty as pointed out to me by J.C.J. Groot (personal communication, July 2014).

To summarize, there are different approaches to intensification of agriculture: to increase productivity either one needs to increase the labour employed, or the amount of natural, financial, or physical capital used. Either approach can lead to sustainable or non-sustainable farming systems.

6.3 Interlinkages

Two main hypotheses are presented and visualised in the following:

1. The access to critical resources for agricultural intensification is different for the two genders. In many countries women are more likely to be constrained (Fig. 6.3).
2. A change in agricultural practices will inevitably influence gender relations (Fig. 6.4).

Section 6.2 explained how combinations of labour, financial, physical and natural capital can be employed to achieve an increase in production. In many countries of the South women are likely to be discriminated in the access to these resources, as depicted in Fig. 6.3 below:

- Labour: women often lack sufficient time to increase the amount of labour they employ for agriculture because of their triple burden (domestic, productive and community tasks).
- Physical capital: Social norms may hinder women to use certain machinery or technology if the use of technology is considered to be a male responsibility.
- Natural capital: Women are often discriminated in their access to land.
- Financial capital: Due to their high engagement in domestic work and in lower valued employments women also have less income. Legal systems in which land and buildings are owned under the name of the husband only may restrict women access to credits also.

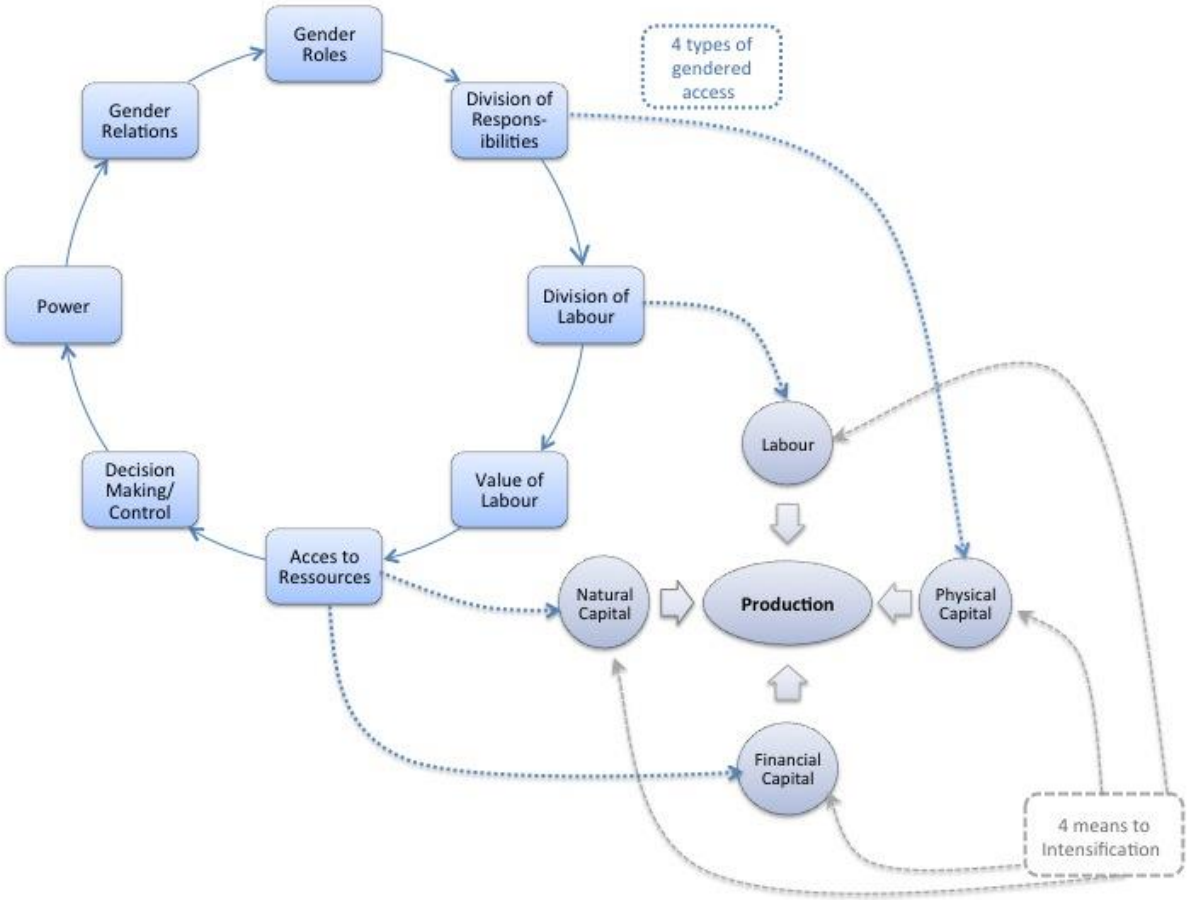

Fig. 6.3 Conceptual framework showing 4 types of gendered access to productive resources necessary for agricultural intensification.

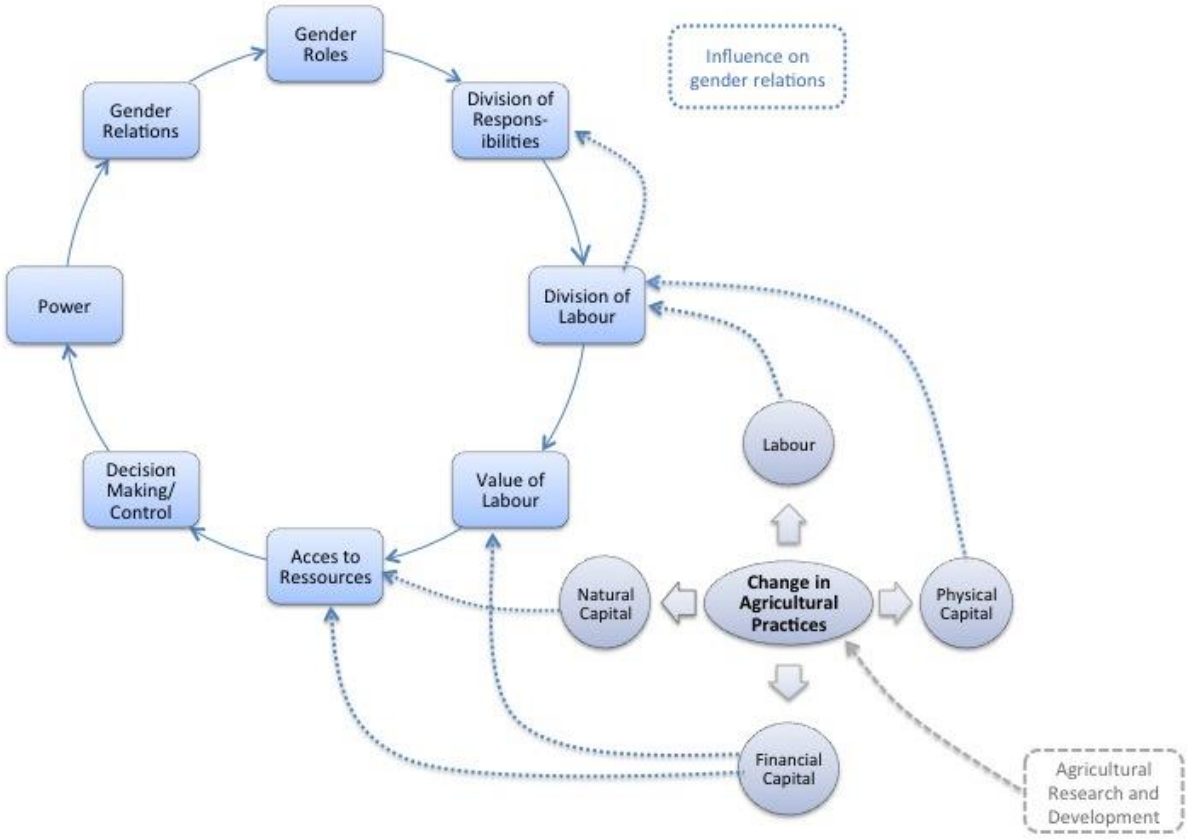

Fig. 6.4 Conceptual framework showing how agricultural research and development impacts on household's gender relations.

Fig. 6.4 shows the different ways in which a change in agricultural practices as suggested by research and extension can influence household gender relations. Agricultural intervention has often effected gender relations negatively, but it is argued that it also holds the opportunity to raise gender equality among farming households.

- In the case of labour: A change in agricultural practices implies different labour requirements. As explained above introduction of technology that targets only men's working domains can reduce men's working time while the labour burden of women stays the same or even increases (e.g. when the use of tractors is promoted that facilitate men's work of land preparation so that they can increase the cultivated area which leads to more work for women in case they are responsible for weeding and harvest). Yet agricultural innovations could also be designed in such a way that the gender specific labour burdens become more equal.
- In the case of physical capital: new technology is often targeted at men. This also applies if it to be used in a traditionally female working domain. This often results in

a new division of labour and also income possibilities (e.g. pounding of maize by hand is done by women, but mills are often operated by men, or subsistence vegetable production and sales at the market are done by women, but as soon as a crop is promoted as a cash crop and sold in large scales, men might take over responsibility).

- In the case of natural capital: Agricultural Intervention can either build or deplete natural resources. The impact of sustainable intensification can be positive for women's access to natural capital, for instance if formerly degraded land is ameliorated or trees are planted that sustain the households need for fuel. Yet investing in the fertility of plots that are typically managed by women might also lead to them losing their land use rights.
- In case of financial capital: Agricultural intervention can increase the productivity of a certain crop along with the income that can be obtained from it. Intensification of domains that are women' s responsibility holds the opportunity of raising their access to financial capital, yet again this requires careful evaluation, because men might take over a business once the value of the connected labour has increased. Raising the productivity of a working domain changes income opportunities and the value of labour. This might result in a new division of responsibilities that might not be of benefit for both genders.

6.4 Preliminary Conclusion

The complexity of social relations does not allow for simple conclusions on suitable interventions.

Based on the conceptual frameworks presented above one can argue for two different approaches to integrate gender in agricultural research that aims at sustainable intensification of small-scale farming systems.

1. Gender –responsive approach

Environmental and economic changes demand a redesign of agricultural production systems in order to sustain livelihoods. The aim of the gender responsive approach to agricultural research is to find solutions that decrease poverty and malnutrition without depleting the natural resource base or increasing gender inequality. As shown above changing farming practices will inevitably influence gender relations. Therefore a gender-responsive approach

to research is needed that ensures that women's and men's practical needs are equally addressed and interventions will harm either of them. Existing gender inequality is not addressed in this approach; one does not aim to change the established social system. It can be argued that the connected barriers to access to resources will make it impossible to design interventions that are of equal benefit to men and women (B. Bock, personal communication, August 2014). Yet gender-responsive agricultural research is a necessary first step towards approaches that aim to increase gender equality.

Gender responsive research addresses women's and men's practical gender needs. To enable this, it is crucial to assess and analyse men's and women's specific needs, the division of working domains, possible inequalities in their access to key resources and also differences in their constraints and motivations in farming.

Besides preventing negative impacts on the household gender relations, gender-responsive agricultural research is important because of two main reasons:

- Being blind for the gendered nature of a farming system can undermine the adoption of new farming practices.
-For the quality of data: neglecting women's contribution to agriculture is to leave their knowledge and skills unused.

2. Gender-transformative approach

It was shown above that access to critical production resources is gender biased and that agricultural intervention can be key to decrease gender discrimination. Consequently agricultural research could aim at contributing to a change in gender relations, women's agency and access to resources and thus contribute to the empowerment of women, in other terms to provide for women's gender strategic needs.

Above aiming at gender equality as an objective in its own right, more equal gender relations could also have positive side effects on the efficiency of farming systems:

- In terms of labour allocation: equal sharing of the total labour burden can enhance total labour productivity of a household.
- In terms of resource allocation: Equal access to physical, natural and financial capital could boost the production of women's plots.

Yet as a gender-transformative approach to agricultural research is aiming at gender equality, the designed interventions could in theory also constrain the productivity of the farming system.

Gender-transformative agricultural research should be based on the same information gathered in the gender-responsive research. In addition it should be analysed how existing inequalities could be changed, i.e. what the gender strategic-needs of men and women are. To meet these strategic needs it is necessary that men and women change their roles, which requires a process of negotiation between genders that should be facilitated within a participatory research approach (B. Bock, personal communication, August 2014).

7. Inclusion of gender analysis in the DEED-approach

This chapter first presents the DEED-approach to farming systems analysis and then suggestions how to integrate gender analysis in the approach.

7.1 The DEED approach

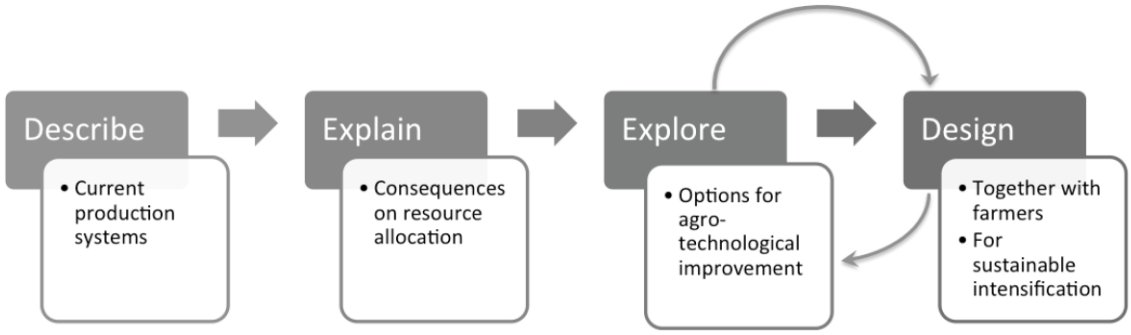

Fig. 7.1 The DEED-approach

DEED is short for Describe, Explain, Explore, Design. These are four steps in a research framework developed for predicting the feasibility, impact and trade-offs of changes in agricultural management at farm level by Giller et al. (2011). The framework aims to provide insights ex-ante implementation. Therefore the integration of gender analysis that would allow to predict positive or negative effects of changes in agricultural managements on household gender relations would be extremely valuable. The four steps of the approach are illustrated in fig. 7.1. A detailed description of them is given in Giller et al. (2011) and summarized in table 7.1. The first three steps aim to identify promising options for a change in agricultural practices that are then discussed with farmers and development agents in a participatory way. It might be necessary to repeat this iterative cycle of modelling and discussion several times. The discussions themselves are valuable for co-learning of researchers and stakeholders, providing the researchers with a reality check for the model-based results and with new ideas for possible amendments to the farming system. The farmers learn about the processes in their farming system and about trade-offs between different technology options (Giller et al. 2011).

Table 7.1 Steps and Activities of the DEED approach (Giller et al. 2011)

	Activity	Details	Methods
DESCRIBE	**Background information**	-Socioeconomic (market, infrastructure) -Institutions -Agroecology -Farming Systems	Literature Review
	Survey	-on diversity of households	Designed in collaboration with local researchers and development workers, sample size: 50-100 in one sub-location,
	Typology	- based on production objectives, orientation or resources constraints	-Participatory -Qualitative Analysis of field work with farmers and their production objectives -Multi-variate statistics
	Detailed system description	-Production activities -Main resource flows (cash/labour/nutrients) -peak period of demand for labour	-Random sample of an equal number of case study farms in each farm type -Interviews with farmers: recall data on labour, yields etc. -Resource flow mapping -Resource use calendars -Soil analysis -Yield estimation in field -Repeated visits (often over a whole year)
EXPLAIN	**Model-based synthesis**	Simplification of case study data to ‚virtual farms'	-Different component models (e.g. FARMSIM, Farm DESIGN)
EXPLORE	**Exploration**	of different scenarios of resource allocation based on current or increased availability of resources e.g. - effects of climate change - investment in nutrient sources (fertilizer, manure) - reduced or increased availability of labour -changing farm size -etc. depending on research question	-Model
	Identification of technologies	options of best suited technologies based on short and long-term implications identified in the exploration	-based on model results
DESIGN	**Discussion and feedback**	On model based results	-with development agents and farmers -trade-off analysis on different technology options -action research on applicability of technology options

7.2 The Basis: Including Female Farmers during the entire Research Process

Participatory Varietal Selection (PVS) is a tool used within the International Rice Research Institute to identify varieties that meet the farmer's needs. The PVS protocol systematically includes gender and imposes a rule that at least 30% of PVS participants need to be women. The guide to PVS also includes a detailed description of constraints that researchers may face in involving women and other disadvantaged groups and recommends strategies to overcome those (Paris et al. 2011).

Based on the fact that women constitute on average 43% of the agricultural labour force in the so called developing countries, one could even argue on higher participation rates of women.

Yet, unfortunately the description of the DEED-approach mentioned above, as well as many other publications in agricultural sciences, does not include any information about how many female farmers participated in research activities.

Within the DEED-framework, participation of women can be achieved at two stages: the survey and the discussion with farmers. Often surveys are conducted with the male household head, as it is assumed that he is most knowledgeable about the farming system. An alternative in order to include more women is to conduct the survey together with male and female household members or in case of very large sample sizes to aim at equal amounts of male and female respondents within the entire sample. This would allow considering the perspective of female farmers. Even if surveys often concentrate on quantitative data (household size, cultivated area, labour hours etc.) the recall based answers will also reflect the respondents' perception of the reality or their desire to present themselves well. Case Study results indicate that the answers of women and men of the same household may differ considerably as presented in Box 3 below.

These conflicting answers highlight how valuable it can be to talk to both male and female farmers but also that information gained from surveys should always be cross-checked with observation data.

Box 4: Case Study: Differences in answers of male and female respondents

In household K1, husband and wife gave considerably different information on key production data during the survey and the qualitative interview (see table and graph 5.8).

Table 7.2 Different answers of husband and wife in household K1

	Male respondent	Female respondent
Plots	1: 1 ha sunflower	1: 1 ha: 0.6 ha local maize 0.2 ha groundnuts 0.2 ha sunflower
	2: 3.5 ha hybrid maize	
	3: 0.12 ha groundnuts	
	4: 3 ha fallow	2: 1 ha 0.5 ha hybrid maize 0.2 ha soybeans 0.25 ha local maize 0.5 ha popcorn maize
	5: 0.25 ha soybeans	
Vegetable garden	0.25 ha tomatoes	0.25 ha: tomatoes, rape, mustard, onion, banana, oranges, sugar cane
Total cultivated area	4.87 ha	2.25 ha
Animals	1 cow and 1 calf	1 cow
	4 pigs	1 pig
	10 chicken	

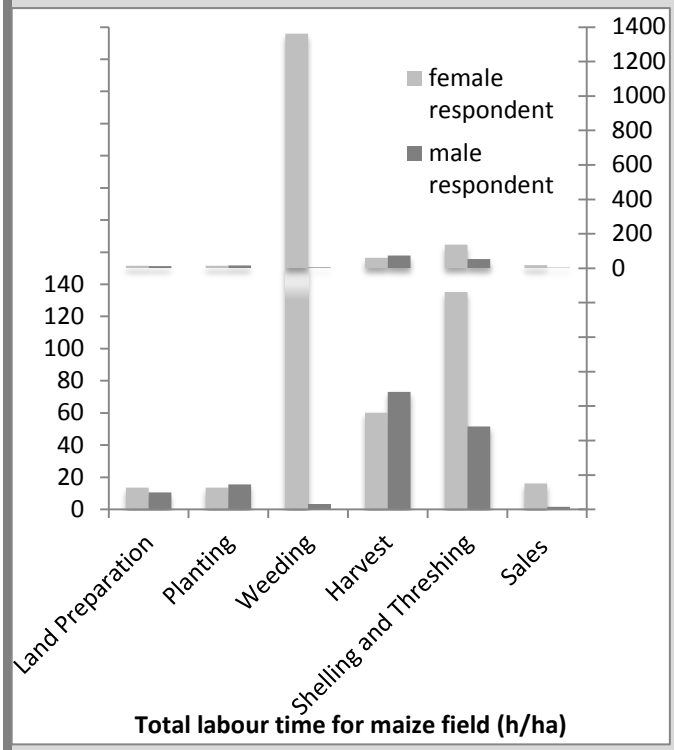

Fig 7.2 Recall of labour time in household K1

While this presents an extreme case, because it could be assumed from his behaviour during the interview and his wife's remarks that the husband had an alcohol problem. Yet it is notifiable because the local male translator suggested using the answers of the male respondent, despite the impression of the researchers that his wife could be trusted more. It is also interesting, that the female respondent mentioned a much larger variety of crops and gave much higher estimates for the labour of weeding and shelling and threshing. It can be concluded that despites male respondents said that male and female workers would share these tasks, they might be part of women's responsibility domain and men therefore

underestimate the labour needed. (More information on the gender division of crop labour is given in section 8.1.4). Respondent K1m reported to cultivate a much larger area and to own more animals than indicated by his wife. It was also observed that there was only one pig in the stable. The tendency to report more animals than were actually owned could also be seen in the answers of respondent C4m. He said that he was married and owning 110 broiler chickens, whereas the woman told that they were only engaged and the chicken- that she also showed to the researcher-were hers**.**

Another example for differences in answers of female and male respondents is presented in Fig. 7.3. It shows how male and female respondents estimated the time that their wife respectively they themselves spend daily on household tasks. It is interesting to see that while in two households the labour requirement indicates by female respondents is bigger than the one indicated by men (households K5 and L5); two households give consistent answers (households K2 and L4) and one male respondent estimated his wife's household labour to be much more time consuming than she herself (household L5).

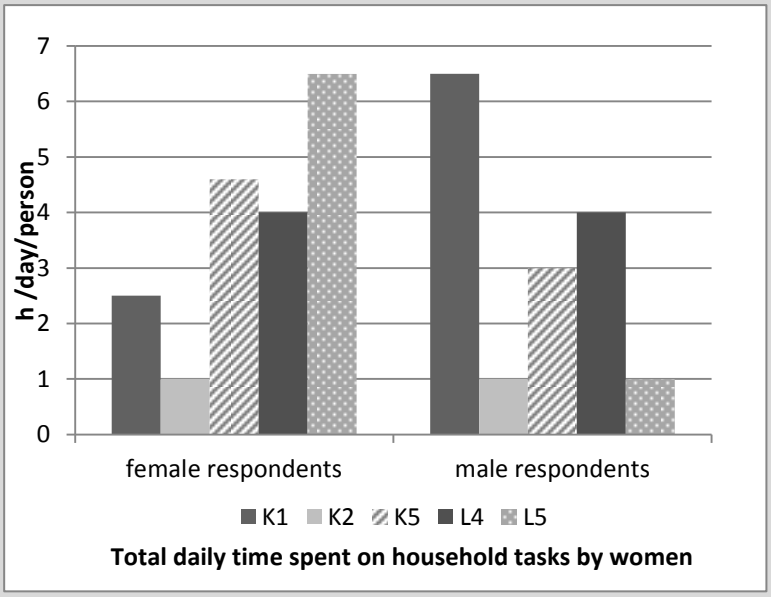

Fig. 7.3 Differences in male and female answers regarding time requirement for household labour

These answers reflect that irrespective of their gender, respondents have different perceptions of how time consuming household work is, or maybe even of what tasks are to be considered as 'work'. It cannot be concluded that men generally perceive household work to be less time consuming than their wives.

7.3 Gender-responsive and -transformative extension to the DEED-approach

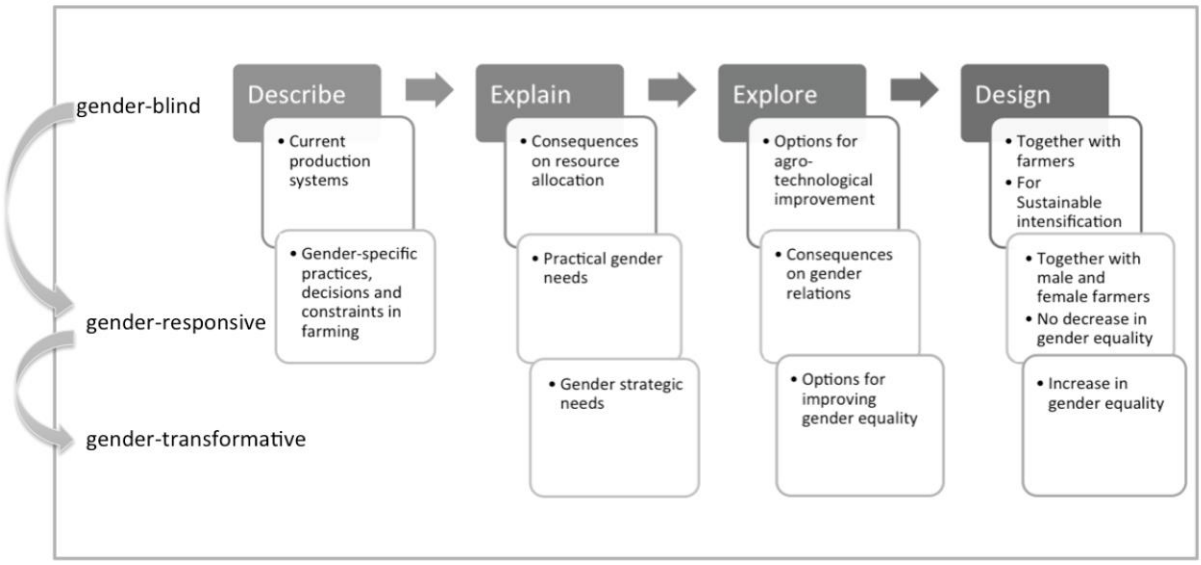

Fig.7.5 Gender-Responsive vs. Gender-Transformative extension to the DEED-approach

Based on the preliminary conclusions from the conceptual framework analysis presented in section 6.4, two different approaches for an extension of the DEED approach can be developed: The gender-responsive and the gender-transformative approach.

Both imply that gender analysis has to be conducted in addition to the analysis of farming systems from an agroecological and economic point of view (see fig. 7.5). As explained above, the gender-responsive and gender-transformative approach differ primarily in their objectives. The gender responsive approach aims to prevent that changes in agricultural practices harm gender relations. The gender-transformative approach aims at designing a farming system that is more gender equal. For the first approach, assessment of gender differences is necessary in four domains: A) gender-specific division of agricultural labour; B) decision making and responsibilities in agricultural production; C) control over income and expenditure and C) the gender-specific constraints to access production resources.

This is used to identify practical gender needs and to allow for an exploration of how changes that are proposed from an economic and agroecological point of view will affect the four domains.

The gender-transformative approach analyses the same data as obtained for the gender-responsive approach but aims to identify gender strategic needs and explore different options for an enhancement of gender equality. Table 7.3 presents a summary of suggestions regarding different research activities and objectives that could be employed in

in order to make the DEED-approach gender responsive or gender-transformative. These activities would need to be done in addition to the analysis of the farming system as presented in table 7.1 above.

It is above the scope of this thesis to evaluate the feasibility of all the proposed activities. The following chapter will present the case study results. This serves to demonstrate how the research framework could look like and which questions could arise and be answered within.

Table 7.3 Additions to the DEED-framework following a gender-responsive or -transformative approach

	Activity	Gender-responsive	Gender-transformative	Methods/Source
DESCRIBE	**Background information**	-decision making and responsibilities in agricultural production gender division of labour -control over income and expenditure -gender differences in access to resources		-literature review/ WEAI or pilot study including focus group discussions with male and female farmers, field observation, and interviews with local experts
	Survey	-on diversity of households -include information on labour availability		-survey design in cooperation with local experts -sample size: 50-100 in one sub-location, -equal number of male and female respondents -dependency ratio -crosscheck with observation
	Typology	- based on production objectives, orientation or resources constraints -consider possibility to have female-headed households as a distinct type		-participatory or qualitative analysis of field work with farmers and their production objectives or multi-variate statistics
	Detailed system description	For the randomly selected households: A: decision making and responsibilities in agricultural production B: gender division of labour -peak period of demand for labour -labour time for household tasks C: control over income and expenditure D:gender differences in access to resources E:gender differences in objectives regarding farming F:gender differences in the perceived constraints of the farming system		-random sample of an equal number of case study farms in each farm type -Separate interviews with male and female farmers: recall data on labour, yields etc. -field observation
EXPLAIN	**Model-based synthesis**	simplification of case study data to ‚virtual farms'		-different component models (e.g. FARMSIM, Farm DESIGN)
	Qualitative Synthesis	Identification of gender practical needs	Identification of gender strategic needs	-focus group discussions with male and female farmers
EXPLORE	**Exploration**	of different scenarios of resource allocation and their consequences on A to D (above)	of different scenarios of resource allocation and their consequences on A to D and considering E and F (above) with the objective to increase gender equality	-model
	Identification of technologies	options of best suited technologies to enhance farming system while not harming gender relations	options to promote gender equality while ensuring or increasing farm productivity	-based on model results
DESIGN	**Discussion and feedback**	on model based results, focus on productivity of farming system while ensuring that male and female farmers agree on the proposed intervention	on model based results, focus on how a change in farming practices and division of labour can lead to more gender equality	-with development agents and male and female farmers -trade-off analysis on different technology options -action research on applicability of technology options

8. Case Study Results

This chapter presents the results of the 8 qualitative interviews that were performed with female farmers and additional information from the survey of all 14 households selected for the detailed household characterization in the Eastern Province of Zambia. The 5 qualitative interviews with married women focused on the division of labour among household members and on the question if women were constrained in their time for child care or other activities. The 3 interviews with single living women focused on the special situation and problems of female headed households. In addition information on time requirements of crop labour and household composition was retrieved from the surveys.

Due to organisational reasons it was not possible to conduct interviews in all of the households that were selected for the detailed household characterization. Further it was infeasible to triangulate interview data with other sources such as observation or other interviews with male informants. Yet the aim of the case study was not primarily to provide information on gender relations in farming households in the case study location but to explore the feasibility of the methods suggested in chapter 7. The following is structured according to the steps of the DEED-approach: Describe Explain, Explore, and Design. Each section provides some examples how the DEED approach could be extended in a gender-responsive and gender-transformative way. It does so using the example of labour. As shown before the description is the same for the gender-responsive and the gender-transformative approach. For the other steps, examples for both approaches are given.

8.1 Describe: Gender Division of Labour

8.1.1 Background Information

There is a vast amount of literature on gender relations in different locations that could be a very useful source of information in the preparation phase of conducting research in farming systems analysis. Due to time constraints, it was not possible to include a literature review on the special situation in Zambia. Therefore the WEAI results for Zambia presented in Box 3 were used to diagnose the domain in which gender differences are most severe. They indicated an excessive workload as one of the major constraints for women. Furthermore Zambia had the lowest ratio of women that exclusively breastfed among the 13 countries compared (see Box 3). This is why the gender division of labour was chosen as main focus of the analysis. It can also be hypothesised that a high workload is one of the factors that

contributes to women reducing the period of breastfeeding. This is why questions on how women combine fieldwork and childcare were included in the qualitative interviews.

8.1.3 Survey and Typology

The case study was conducted in the course of the detailed system description of farm types that were identified based upon an existing baseline survey. It could have been interesting to include not only the household size as a factor to the typology, but the household dependency ratio. The dependency ratio is a ratio of those people that are not part of the labour force (usually defined by age below 14 and above 65) and those active in the labour force.

Table 8.1 Size and dependency ratio of selected households

Household	Household size	Dependency ratio (%)
Chipata 4	10	66
Katete 1	2	0
Katete 2	6	200
Katete 5	11	57
Lundazi 5	13	60

Table 8.1 gives an overview of the dependency ratio in relation to the household size for the households in which qualitative interviews and surveys were conducted. It can be seen that the dependency ratio is not connected to household size and would thus constitute a more accurate indicator for labour available within the household but also labour needed for domestic tasks. It could be an option to define the labour force as those that are actually contributing household or agricultural fieldwork, (thus also including children below 14 and excluding people who cannot contribute farm labour, because they work off-farm or are disabled). It could also be interesting to look whether children under 1 or 2 live in the household, because they need especially attentive care.

Looking at labour availability in the typology would allow targeting interventions according to their labour requirement. One could also consider analysing female-headed households as a distinctive type. This would allow designing farming systems that meet their specific needs and are adapted to the constraints they face.

8.1.4 Detailed System description

Gender Division in Agricultural Labour

a) Joint responsibility for fields, separate responsibility for animals

All interviewed households stated that they had either joint responsibility for their fields or the fields were the responsibility of the husbands. In no case it was mentioned that a field or vegetable garden was managed by a female household member independently. Women consistently said that they would feed the farm's chicken or pigs. Respondents K5 and L5 said that they would own some animals independently from their husband and would use them as a personal source of income (9f (chicken and pigs) and 13 f (pigs))]. Cattle and goats are normally herded, a task only done by men or boys.

b) **Gender division of field labour**

During the detailed household characterization survey, respondents were asked to recall the working time of household males and females as well as hired males and females for the cultivation of each crop in the preceding growing season. The tasks that were asked for are land preparation, planting, weeding, harvest, shelling and threshing, processing and sales. The main crops that were grown were maize, groundnut and sunflower.

Fig. 8.1 and table 8.2 show the results of the households in which also qualitative interviews were performed. As discussed in Box 4 the information given by the male respondents based on recall, can only serve as a rough estimation of the actual labour time. Yet some general trends can be highlighted.

Cropping labour is done jointly. The ratio of female to male working hours in agricultural labour for household members lies within a range of 22 to 61 % (Tab. 8.1). K2, the household with the lowest female share in agricultural labour also has the highest dependency ratio of 200%. Moreover it was explained by the male respondent that his wife had health problems after a Caesarean section (Survey K2m). For the other four households the female share in agricultural labour is around 50%.

Table 8.2 Household size and division of crop labour

Household (HH)	HH-Size	Dependency Ratio (%)	Ratio of female to male working hours in total crop labour of HH members (%)
Chipata 4	10	66	61
Katete 1	2	0	51
Katete 2	6	200	22
Katete 5	11	57	55
Lundazi 5	13	60	50

This is an indication that cropping labour is done jointly, which was confirmed in the qualitative interviews.

Women consistently said that all working household members would go to the fields and work there together. (Interviews K2, K5, L5). From the survey results depicted in Fig. 8.1, it can be seen that there is no clear division of the different tasks among females and males. Land preparation and sales are the only tasks that were mostly done by men. The most laborious tasks were harvest and weeding, yet with large differences between households. They are done by men and women in almost equal shares. The respondents mentioned hardly any labour time for processing.

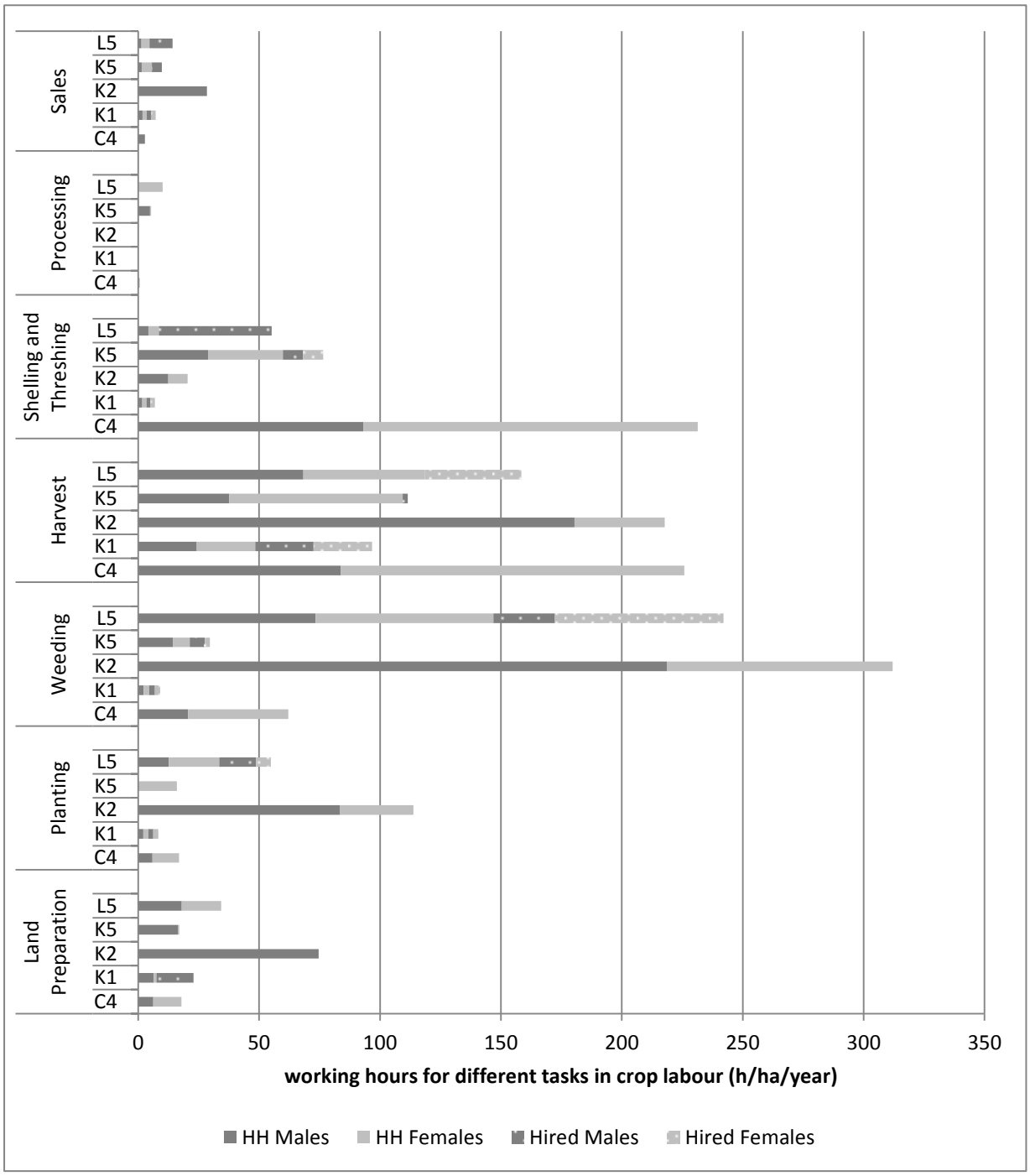

Fig 8.1 Gender division of Crop Labour

Interview results confirmed this information on gender division of labour. Whereas women said that women could not use oxen, there were no cropping tasks mentioned that were generally not performed by men, pointing to cropping tasks largely being done jointly. Female interview respondents explained that **land preparation** by hoe (constructing of ridges or potholes) is done by men and women together, while only men do ploughing and

ripping with the help of an oxcart. In case the soil is ripped, women follow the oxen to **plant** at the same time. This explains why land preparation is done in some households only or mostly by men (K5, K2, K1) and in others by men and women (C4, L5) and why planting is only done by women in household K5. There are large differences in the household's labour allocation to **weeding**. Only for household K5 this can be attributed to the use of herbicides (Survey K5m). The other differences might be due to varying weeding requirements of different crops and or unreliable information (K1, see box 4).

Consistent to the information by the male survey respondents on the large amount of labour needed for **harvest**, a female farmer stated that the harvest season is the busiest time during the year (Interview C).

The respondents mentioned hardly any labour time for **processing**. This can have several reasons. Firstly all interview respondents said that they brought their maize and sunflower to a mill to get meal and oil, which of course decreases the needed labour substantially. Secondly considerable amounts of the harvest were used for home consumption. As a consequence, processing was done in little parts, whenever something was needed for cooking- e.g. it was estimated that pounding groundnuts for one meal would take ½ hour. But of course this time would add up when considering the whole harvest. It can also be that male respondents were unaware of female labour tasks: In one case the husband said that his wife would take the maize to the mill, which would take her 1 hour per month. Yet his wife explained that the hammer mill they were using required additional pounding by mortar to get fine white meal. This would require an additional 8 hours of her work per month (Survey L5m, Interview L5f).

Sales: As interview respondents explained, only men use oxcarts. This also implies that they are the one taking the main harvest to the market while women sell vegetables or fruit in small quantities. Yet respondent K5f said that she would go to the market and sell their products together with her husband, respondent K1f said that she would sell all of their farm's product, because she thought that her husband was not capable of doing so (Box 4).

It also needs to be noted that some tasks may have been forgotten because they were not included in the survey: e.g. watering the vegetable garden was mentioned by two women when asked about tasks that are very time consuming. Respondent 8f said that she spends 1 hour each day watering the vegetables during the whole dry season (i.e. 240h/year). Respondent A said that she waters every day for 3 hours during 5 months (i.e. 450 h/year).

Gender Division of domestic labour

> *„I work more than my husband. After fieldwork, when I need to cook and do other things in the household, my husband can just rest" (Interview K5f).*

Seven of the eight interviewed women said that women have a higher labour burden than men because they need to do household-tasks on top of their work in the fields. The women's estimates of how much time they need for daily household work ranged between 1 h to 6.5 hours. This reflects not only differences in households' labour requirement but also in women's perception of work. Table 8.3 presents Interview results on how men and women share different domestic tasks.

It can be noted that women perform the daily tasks in addition to the agricultural labour, while the weekly or seasonal tasks are done instead of agricultural labour, which is important to consider to get information on the general availability for agricultural labour. It is not possible to conclude how common it is that men help to collect water or firewood from the Interview results. Respondent K5f said that the household would use the oxcart regularly to get water, unless it was needed for land preparation. Respondent K2f said that her husband collected firewood to help her with household tasks, which was judged as exceptional compared to other men by village women listening to the Interview (Interview K2f). The other female interview partners said that they would always walk to fetch water and collect firewood.). The time these women allocated for these tasks varied depending on the availability of the two resources. Respondents A and C reported that wood was scarce and collecting firewood was the first or second most time consuming domestic task (Interviews A, C). On the contrary, respondent K 5 reported that it took her only 5 minutes per day to collect wood, because the family owned a piece of wood directly next to their house. The two single women in interview A also pointed at water scarcity as a major reason for labour constraints. They said that the village water source was dry during 3 months of the year and during that time they had to walk 3km to the next water source, which would take them 90 minutes and in total 4.5 hours because they needed to go 3 times a day (Interview A).

Table 8.3 Gender division of domestic tasks

Daily		weekly		monthly/ seasonal	
female	male	female	male	female	male
-drawing water -sweeping -washing dishes -making fire -cooking -nursing children -bathing children	-drawing water	-collecting firewood -washing clothes	-collecting firewood	-smearing house -cutting grass for roof -caring for sick family members -cooking for hired labourers	-building house and toilet -renewing roof

Time constraints in relation to childcare

Given the equal participation of men and women in agricultural labour, it was asked how women manage to care for their small children at the same time. The interview responses indicate that whether a woman is able to rest enough during pregnancy and spend enough time for breastfeeding is not a matter of preference but rather of the household's financial situation. It depends on whether they can afford extra labourers or a productivity loss as a consequence of the wife's reduced working hours. Respondent L5f - living in a type 5 household, one of the highest resource endowed farms- said that her husband allowed her to quit fieldwork earlier when she was pregnant and that she had enough time to nurse her children (Interview L5f). Respondent C, who is married to a teacher, was more concerned. She explained caring for her children restricts the time she can be on the field and as a consequence she has to rely on more hired labour. Despite asking her husband earlier, she was not allowed to reduce her working time until the 8th month of pregnancy. While she herself did have enough time for breastfeeding, she had the impression that other women whose husbands had less income didn't. Village women that listened to Interview K2 also pointed to the problem that some women would find it too hard to breastfeed while working on the field. They would leave their babies crying and had to take them to the hospital because of malnutrition after a while (Interview K2). Also respondents K1 and K2 said that they had to work until delivery, although they think this brings sickness to the child, and also did not have enough time to breastfeed (Interviews K1, K2).

Situation of female headed households

Constrained in labour: When asked about problems single living women had compared to married couples, respondent B explained that married couples are able to achieve higher yields because they have more labour available. For her it is costly to hire labour for all the tasks that are normally done by men (oxcart for land preparation and collecting firewood, construction of granaries). Also the two respondents of Interview A said that they were labour constrained compared to married coupled, because they had nobody working on the fields, whenever they need to do the necessary household tasks. They mentioned that they had to cease crop labour during periods of drought, because they have to spend so much time to collect water. They said that this had caused them to be food insecure. Respondent 3f who lived alone during the previous years emphasized that it was really hard labour for her to be able to support her daughters from her agricultural income but her daughters had also worked a lot (Interview C4f).

Constrained in access to land: All respondents lived in patrilineal communities. Here the traditional system of land inheritance regulates that land is given from a father to his sons and daughters will normally leave their parents village to live on her husband's property upon marriage. This means that in case of a divorce, women normally have to go back to their parent's village. In case there are no brothers using the parent's fields (Interview C4f), or if there is enough community land available (Interview A, B), this is no problem. But conflicts arise when a divorced woman has no other option than to live with her married brother and the available land is scarce (explained by respondent C4f) Widows can stay on their husband property, but only in case they have children (Interview L5f).

8.2 Explain: Consequences of the gender division of labour

As described in section 7.3 the ‚Explain phase' of the DEED-Framework should be extended in a gender-responsive approach to identify practical gender needs. A gender-transformative approach would require the identification of strategic gender needs. Ideally this should be done in a participatory manner involving male and female farmers and also children involved in agricultural labour. It should also be cared for that ethnic or religious minorities get the opportunity to voice their specific needs.

Whereas practical gender needs derive from a person's gender role and the associated responsibility for certain tasks, strategic gender needs are those whose fulfilment would lead

to a more gender equal society and thus requires that established gender roles are changed (see section 5.2.1).

During the qualitative interviews the women were asked how they thought the situation of female women could be improved. Table 8.4 presents the results and a classification and classified whether the needs that were mentioned constitute practical or strategic gender needs.

Table 8.4 Suggestions how to improve the situation of female farmers

	Labour saving technology	**Access to agricultural extension**	**Access to Financial Capital**
Practical Gender Needs	-treadle pump (A) -herbicide use (L5f) -more hired labour (L5f)	-need knowledge about farming (A, L5f) -	
Strategic Gender Needs		-need agricultural extension for gender sensitization (L5f)	-any income generating business (B) -own cattle or small animals (C)

All labour saving technology can be classified as practical gender need, because it would reduce women's working hours but not influence the gender specific division of labour. Depending on the context, access to agricultural extension can be considered both as a practical as well as a strategic gender need. It is a practical gender need for women to learn more about the agricultural practices that they are currently responsible for (e.g. training on how to store chicken or pig manure). Yet one woman also mentioned that she could not attend agricultural extension meetings because her husband would sometimes not tell her about them or sometimes she would have too many domestic tasks. She also said that she would need the extension officer to convince her husband to allow her to start an own business. (Interview L5f). Also respondent C mentioned that women could not own larger animals, because men would not allow this. These are needs that require a change in norms about appropriate behaviour of women, i.e. gender practical needs.

The conclusions from these interview results are limited because they only capture the view of 4 female farmers, whereas it would be necessary to consult male farmers as well in order to facilitate a dialogue on how the gender division of labour in farming could be reorganised.

Table 8.5 presents the answers of female farmers regarding to which crops and animals they would like to have in the future. It would be interesting to compare these results to the answers of male respondents in order to analyse if male and female objectives with regard to farming differ. This could be a starting point to consider their specific objectives and also constraints in the exploration phase.

Table 8.5 Crops/Animals the female farmers would be interested in in the future

Crops	Constraints	Animals	Constraints
sunflowers (C,)		goats (C, K2f)	money
cotton (C)	labour	sheep (C)	money
soybeans (B)	seeds	(hybrid) pigs (C, B, K1f, K5f)	money
beans (B)	seeds	(hybrid) poultry (B, K2f, K1f, K5f)	diseases/ money
potatoes (A)	seeds	cows (A,C)	men would not allow (C)
soybean (A, L5f)	seeds	oxen (A, K1f)	money
hybrid maize (K2f)			
groundnuts (K2f)			
cowpeas (K1f)	labour		
expand area of existing crops (K1f)			

8.3 Explore: Options for change

The advantage of Farm DESIGN is that the computer model can calculate the possible consequences of a variety of different scenarios. For the example of labour, this could be used to calculate the effect of a new crop rotation or a change in animal numbers on the labour burden of men and women. In a gender-responsive approach the objective would be to find options that do not disproportionally increase the labour burden of men or women. The gender-transformative approach would aim at an equal labour burden for men and women, even if that meant to increase the labour burden of men while reducing the one of women. Yet it is also important to note that gender equality in regards to labour cannot solely be defined by the amount of labour women and men have to do. They should also be in an equal position to choose the labour tasks that they enjoy to do. Nevertheless incorporation of the gender division of labour in Farm DESIGN could facilitate the discussion on male and female labour burdens. The following presents some ideas how this could be achieved.

The farming system, characterized by the crops grown, the animals kept and the technology applied, defines the amount of labour needed on the farm. In case of strict gender division of labour (e.g. weeding only done by women, land preparation only done by men), the combination of crops, animals and technology will also result in specific requirements of male and female labour.

The availability of household members for agricultural labour is restricted by other activities they need to perform (e.g. off-farm work, domestic tasks, child care, school, community labour, leisure etc.). The extent to which male and female household members are active in these activities depends on the gender division of responsibilities and the resulting division of tasks. The need for hired labour is determined by the difference in requirement for farm labour and the available labour time of household members. These relations are visualised in Fig. 8.2

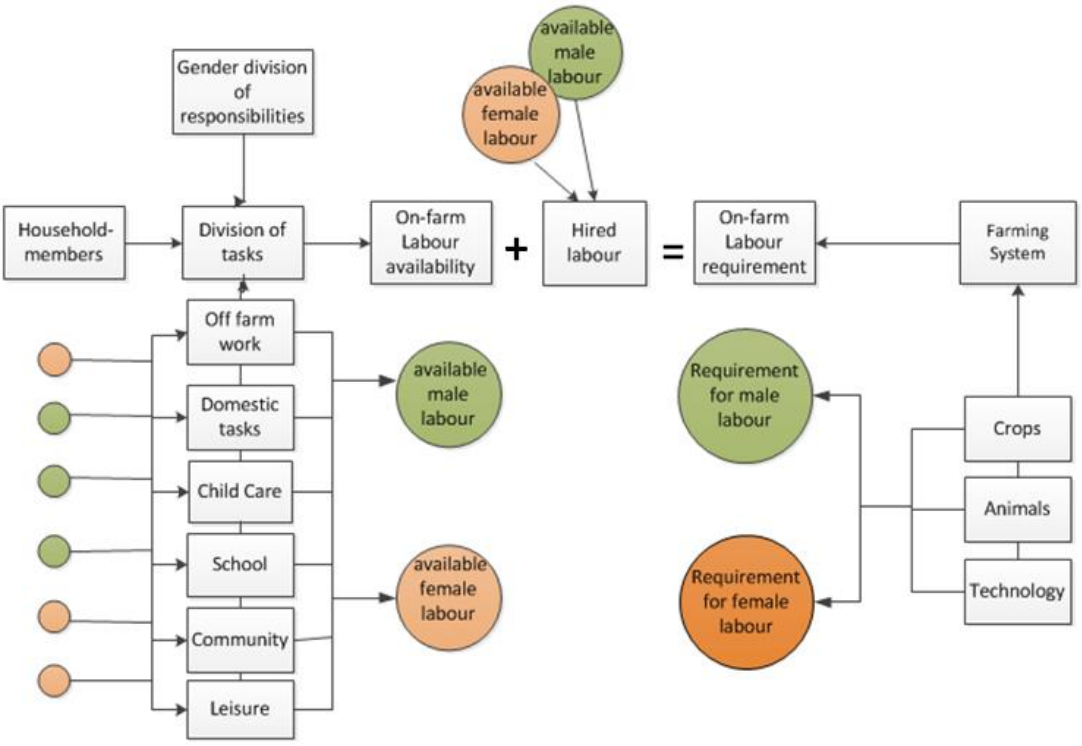

Fig. 8.2 Interlinkages between gender division of responsibilities and on farm labour requirement.

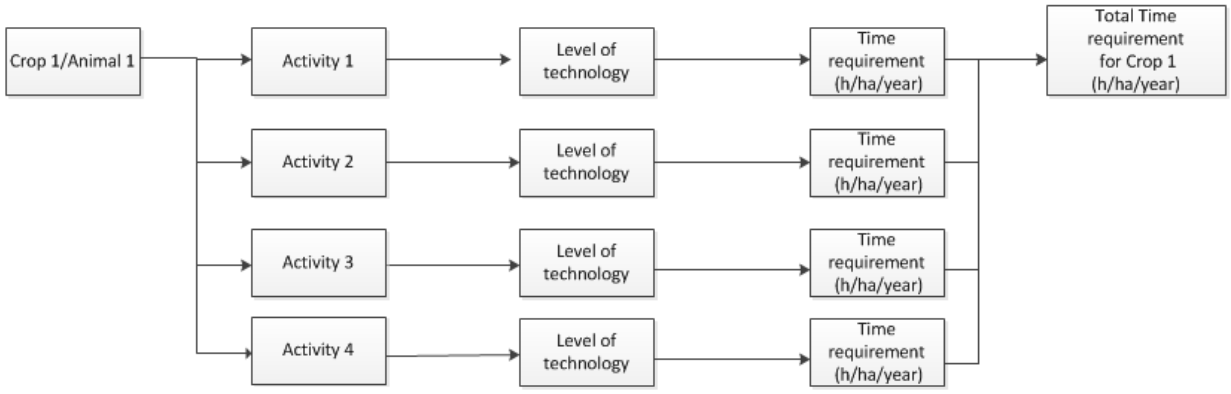

Fig. 8.3 Labour requirement for crops and animals

Farm DESIGN currently calculate total farm labour requirement based on the specific requirements of each crop as identified in the detailed household characterization and literature sources. Farm DESIGN also collects data on the technology used on the farm (e.g. machinery, herbicides). In theory it would be possible to link the activities needed for the cultivation of a crop with the technology level used. The same could be done for each animal type. This would allow showing the effect of a new technology on labour requirement (e.g. use of an oxen plough instead of hoeing by hand for land tillage; or use of herbicides instead of weeding by hand).

The fact that labour requirement would be linked to the level of technology has also the advantage that one could use standard labour requirements: To till a 1 ha field by hoe will roughly always take the same time no matter the location.

Once this time requirement is observed and known, surveys would not need to ask the farmers for the time they spend on the fields but could ask which the activities (and how often) the farmers performed for each crop. Additional field observation could be used to adjust the figures on time requirement for each activity under the used level of technology.

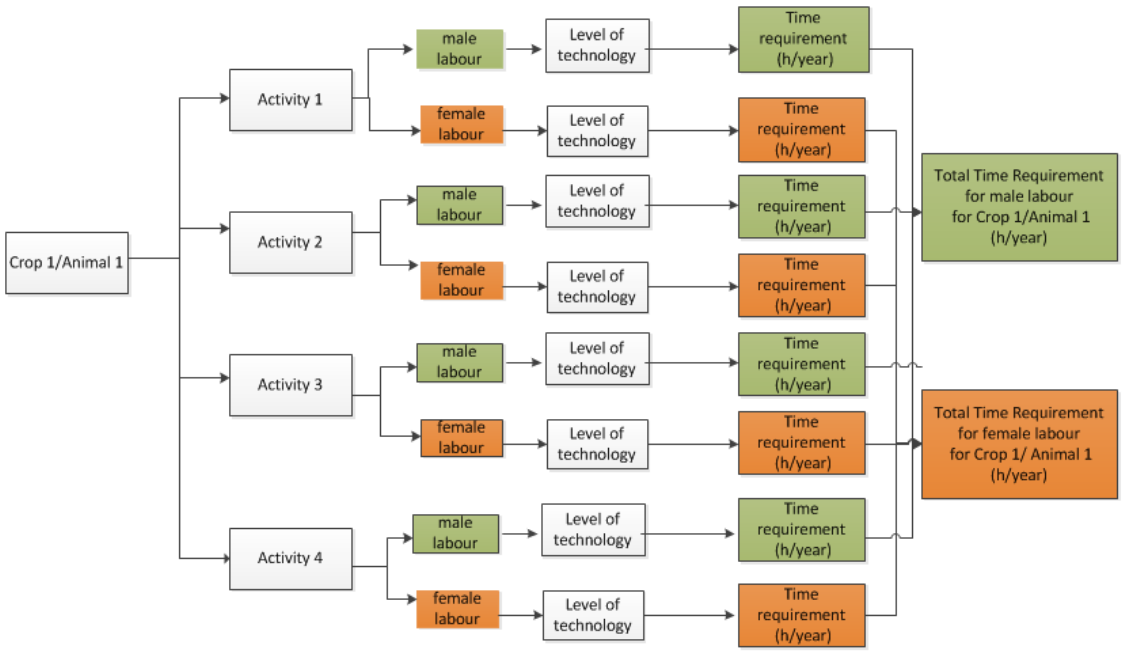

Fig. 8.3 Gender-specific labour requirement of crops and animals

To show the gender division of labour, one could list for each activity, how much of it is done by women and how much of it is done by men. For some cases, there will be a clear division: e.g. tillage only done by men. In some cases where men and women manage separate plots it could also be that men and women do the same activity but using different technology (e.g. men doing the tillage of maize by oxen on their cash crop fields, but women hoeing their smaller plot of maize for home consumption by hand) (fig.8.3). This would allow to show how the use of technologies differs between men and women and to target new technology accordingly. An alternative would be to look at the gender-specific management of different plots, rather than looking at the labour requirements of different crops.

The same could be done for all activities necessary in reproductive work (Fig. 8.4). To list all these activities would have the advantage of showing possible entry points for labour saving technology. It links to the agronomic analysis mainly through its effect on the available time for agricultural labour, but would also sustain the concept of a family farm that functions as a whole and in the context of the community. Moreover, as indicated by case study results, household tasks often compete with agricultural tasks for the same resources while having first priority (Oxen can be used on the field or to collect water; collecting water and cooking needs to be done every day and restricts the time available for agriculture). Including domestic tasks in the model would require a lot of additional information being processed, but the analysis could be facilitated by using standard approximation of required labour time

(e.g. the time needed to collect water is dependent on the distance of the water source and the mode of transportation; the time needed for washing clothes is dependent on the household size and the used technology etc.)

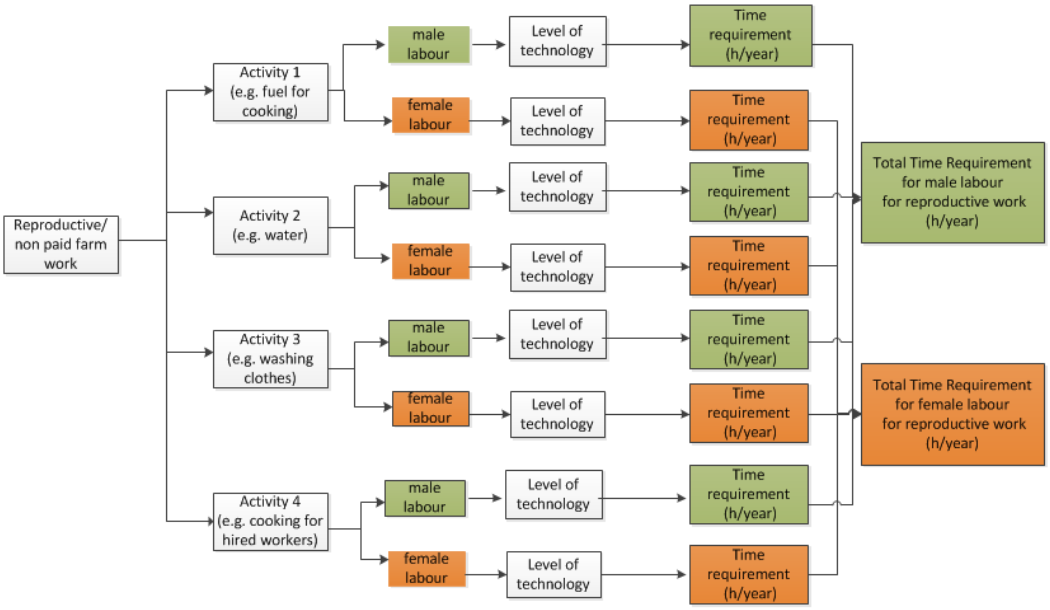

Fig. 8.4 Gender-specific labour requirement for domestic tasks

As Farm DESIGN is already collecting data for each household member, it could be possible to link each person to the activities he or she is generally performing (Fig. 8.5). This would allow to show the effect of a person not being available (e.g. because a person migrated for work, became ill or deceased or a couple got divorced). This could be especially interesting to analyse the special situation of female headed households as they are particularly labour constrained.

Fig. 8.5 Labour needed and performed by each household member

8.4 Design: Towards a more gender-equal farming system

The results of the exploration could be used to facilitate a discussion with male and female farmers.

In the gender-responsive approach, this discussion would focus on productivity of farming system while ensuring that male and female farmers agree on the proposed intervention and neither of their workload is disproportionally increased.

The model could be used to explore the influence of different techniques or combinations of crops on male and female workload, e.g.:

-How would the use of herbicides affect male and female labour burdens?

-How would an increase in animal numbers affect male and female working hours?

In a gender-transformative approach the discussion would focus on how a change in farming practices and division of labour can lead to more gender equality. Model results would be particularly useful to facilitate this discussion. As an example the following questions could be explored:

-What would happen if women reduced their agricultural labour in such a way that their total labour burden would be equal to the one of men?

-What if men collected water with the help of an oxcart? What could be achieved with the labour time saved in this way?

What would that mean in terms of productivity/income loss?

This would be a way to illustrate the value of female labour in agriculture, which could be a good entry point in the discussion on gender relations.

9. Conclusion

The original purpose of this study was to contribute to making farming systems analysis more gender-sensitive, by incorporating gender indicators to whole farm models. It proved that this was impossible within the scope of this thesis. This can be attributed to the complexity of the topic. Yet during the research process it became also clear that adding a new set of indicators to a model is not sufficient to reach gender sensitivity. It also demands that the purpose of data collection is clear. Discussion with the actors concerned can help to identify whether a gender-responsive or gender-transformative approach is needed. The provided conceptual framework and the summary of available tools hope to facilitate the researcher in doing so.

Gender-responsiveness is the minimum to ensure that gender relations are not affected in a negative way. The gender-transformative approach aims to facilitate a process of transformation in established gender roles towards more gender equality.

How both approaches could be implemented was illustrated with the example of labour.

In a first step the gender specific division of labour and the associated differences in labour burden are assessed. This is used to define gender practical and gender strategic needs with the actors. Model based-analysis could be used to simulate the effects of a change in agricultural practices on gender relations, either with the aim to do no harm or with the objective to achieve more gender equality.

It can be concluded that integration of gender assessment in farming systems analysis can lead to benefits on all sides:

- For male and female farmers, because it would allow to target their specific needs.
- For agricultural scientists, because they profit from the knowledge of female farmers and the designed interventions have a higher chance to be implemented effectively
- For gender scientists, because this would allow for a systematic collection of data that can serve as evidence for gender differences in access to resources and time allocation.

References

Africa RISING. (n.d.). About the program. Retrieved August 14, 2014, from http://africa-rising.net/about/

Alderman, H., Hoddinot, J., Haddad, L., & Udry, C.R. (2003). Gender Differentials in Farm Productivity: Implications for Household Efficiency and Agricultural Policy. In A. R. Quisumbing (Ed.), *Household Decisions, Gender and Development. A Synthesis of Recent Research*.

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The Women's Empowerment in Agriculture Index. *World Development*, *52*, 71–91. doi:10.1016/j.worlddev.2013.06.007

Aregheore, E. M. (n.d.). Country Pasture/Forage Resource Profiles Zambia. *FAO*. Retrieved August 07, 2014, from http://www.fao.org/ag/agp/AGPC/doc/Counprof/zambia/zambia.htm

Beaman, L., & Dillon, A. (2012). Do household definitions matter in survey design? Results from a randomized survey experiment in Mali. *Journal of Development Economics*, *98*(1), 124–135. doi:10.1016/j.jdeveco.2011.06.005

Bentley, M. E., & Fields, E. (2003). Household. In *Encyclopedia of Food and Culture*. The Gale Group Inc. Retrieved July 2014 from http://www.encyclopedia.com/topic/Household.aspx#1

Bock, B. B. (2006). 1 Introduction, In Bock, B. B., Shortall, S. (eds.): *Rural Gender Relations: Issues and Case Studies.* CABI

Bock, B. B. (2014, February 10). Gender mainstreaming and rural development policy; the trivialisation of rural gender issues. *Gender, Place & Culture*. Taylor & Francis. doi:10.1080/0966369X.2013.879105

Bontkes, T. S. (1999). *Modelling the dynamics of agricultural development : a process approach. The case of Koutiala, Mali*. Wageningen University.

Boserup, E. (1982). *Die ökonomische Rolle der Frau in Afrika, Asien, Lateinamerika*. Stuttgart.

Butler, J. (1990). *Gender Trouble: Feminism and the Subversion of Identity. Thinking Gender'*. New York & London: Routledge.

Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, & Macro International Inc. (2009). *Zambia Demographic and Health Survey 2007*. Calverton, Maryland, USA. Retrieved from http://dhsprogram.com/pubs/pdf/FR211/FR211%5Brevised-05-12-2009%5D.pdf

CGIAR Consortium Board. (2011). Consortium Level Gender Strategy The CGIAR Consortium Board November , 2011.

Chiappori, P., & Donni, O. (2009). *Non-unitary models of household behavior: a survey of the literature*.

Cornwall, A., Harrison, E., & Whitehead, A. (2007). Gender Myths and Feminist Fables : The Struggle for Interpretive Power in Gender and Development, *38*(1998), 1–20.

Cueva Beteta, H. (2006). What is missing in measures of Women's Empowerment? *Journal of Human Development*, *7*(2), 221–241. doi:10.1080/14649880600768553

Diener, E. (1984). Subjective Well-Being. *Psychological Bulletin*, *95*(3), 542–575.

Duflo, E. (2012). Women Empowerment and Economic Development. *Journal of Economic Literature*, *50*(4), 1051–1079.

Farming First, & Food and Agricultural Organization (FAO). (n.d.). Infographic: The Female Face to Farming. Retrieved August 14, 2014, from http://www.fao.org/gender/infographic/en/

Feldstein, H. S., & Jiggins, J. (1994). Introduction. In *Tools for the field: Methodologies handbook for gender analysis in agriculture*. London: IT Publications.

Food and Agricultural Organization (FAO). (2011). *The state of food and agriculture 2010-2011. Women in agriculture. Closing the gender gap for development*. Rome.

Forum for the Future. (n.d.). *The Five Capitals Model – a framework for sustainability*. Retrieved from http://www.forumforthefuture.org/sites/default/files/project/downloads/five-capitals-model.pdf

Gesellschaft fuer technische Zusammenarbeit (GTZ), & Bundesministerium fuer wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). (2009). *Steps for Action to promote gender equality*. Retrieved April 13th 2011 from http://www.gtz.de/de/dokumente/gtz-en-steps-for-action-2009.pdf

Giller, K. E., Tittonell, P., Rufino, M. C., van Wijk, M. T., Zingore, S., Mapfumo, P., … Vanlauwe, B. (2011). Communicating complexity: Integrated assessment of trade-offs concerning soil fertility management within African farming systems to support innovation and development. *Agricultural Systems*, *104*(2), 191–203. doi:10.1016/j.agsy.2010.07.002

Groot, J. C. J., Oomen, G. J. M., & Rossing, W. A. H. (2012). Multi-objective optimization and design of farming systems. *Agricultural Systems*, *110*, 63–77.

Grynspan, R. (2011). Rebeca Grynspan: Remarks on green growth and gender economic empowerment at the OECD Ministerial Council Meeting | UNDP. Retrieved July 13, 2014, from http://www.undp.org/content/undp/en/home/presscenter/speeches/2011/05/26/rebeca-grynspan-remarks-on-green-growth-and-gender-economic-empowerment-at-the-oecd-ministerial-council-meeting.html

Haddad, L., Hoddinot, J., & Alderman, H. (Eds.). (1997). *Intrahousehold Resource Allocation in Developing Countries: Models, Methods and Policy*. Baltimore: Johns Hopkins University Press for the International Food Policy Research Institute.

Hippert, C. (2011). Women's spaces, gender mainstreaming, and development priorities: Popular participation as gendered work in rural Bolivia. *Women's Studies International Forum*, *34*(6), 498–508. doi:10.1016/j.wsif.2011.07.004

Imai, K. S., Annim, S. K., Kulkarni, V. S., & Gaiha, R. (2014). Women's Empowerment and Prevalence of Stunted and Underweight Children in Rural India. *World Development*, *62*, 88–105. doi:10.1016/j.worlddev.2014.05.001

International Institute for Tropical (IITA). (n.d.). Gender Strategy for Humidtropics.

Ittersum, M. K. van, Ewert, F., Heckelei, T., Wery, J., Alkan Olsson, J., Andersen, E., … Wolf, J. (2008). Integrated assessment of agricultural systems – A component-based framework for the European Union (SEAMLESS). *Agricultural Systems*, *96*(1-3), 150–165. doi:10.1016/j.agsy.2007.07.009

Jabareen, Y. (2009). Building a Conceptual Framework : Philosophy, Definitions , and Procedure. *International Journal of Qualitative Methods*, *8*(4), 49–62.

Kabeer, N. (1999). Resources , Agency , Achievements : Re ¯ ections on the Measurement of Women ' s Empowerment, *30*(May), 435–464.

Kauck, D., Leader, T., Paruzzolo, S., Schulte, J., & December, W. (2010). CGIAR Gender Scoping Study, 1–33.

Kuhn, S. L., & Stiner, M. C. (2014). What ' s a Mother to Do ? The Division of Labor among Neandertals and Modern Humans in Eurasia, *47*(6), 953–981.

Le Borgne, E. (2014). Africa RISING reviews and plans its work in West Africa | Africa RISING on WordPress.com. Retrieved August 14, 2014, from http://africa-rising.net/2014/02/17/west-africa-planning-2014/

Levine, J. a, Weisell, R., Chevassus, S., Martinez, C. D., Burlingame, B., & Coward, W. a. (2001). The work burden of women. *Science (New York, N.Y.)*, *294*(5543), 812. doi:10.1126/science.1064627

Ley, H. (2012). If We Invest in Women, They Can Feed the World. Retrieved August 14, 2014, from http://www.impatientoptimists.org/Posts/2012/03/Sharing-a-Global-Agenda-for-Womens-Empowerment-in-Agriculture

Lindsey, L. (2011). Chapter 1: The sociology of gender. Theoretical Perspectives and Feminist Frameworks. In *Gender Roles: A Sociological Perspective* (5th ed., pp. 1–21). Pearson.

Malapit, H. J., Sproule, K., Kovarik, C., Meinzen-dick, R., Quisumbing, A., Ramzan, F., … Alkire, S. (2014). *MEASURING PROGRESS TOWARD EMPOWERMENT WOMEN ' S EMPOWERMENT IN AGRICULTURE INDEX : BASELINE REPORT*. Washington DC.

Malhotra, A., Schuler, S. R., & Boender, C. (2002). *Measuring Women ' s Empowerment as a Variable in International Development*.

March, C., Smyth, I. A., & Mukhopadhyay. (1999). *A guide to gender-analysis frameworks*. (OXFAM Great Britain, Ed.).

Marshall, G. (1998a). Domestic labour. In *A Dictionary of Sociology*. Retrieved August 7th 2014from http://www.encyclopedia.com/doc/1O88-domesticlabour.html

Marshall, G. (1998b). Household. In *A Dictionary of Sociology*. Retrieved July 17th 2014from http://www.encyclopedia.com/topic/Household.aspx#3

Marshall, G. (1998c). Household work strategy. In *A Dictionary of Sociology*. Retrieved August 7th 2014 from http://www.encyclopedia.com/doc/1O88-householdworkstrategy.html

Meinzen-Dick, R., Koppen, B. Van, Behrman, J., Akamandisa, V., Hope, L., & Wielgosz, B. (2012). *Putting Gender on the Map Methods for Mapping Gendered Farm Management Systems in Sub-Saharan Africa* (Vol. IFPR).

Meinzen-Dick, R., & Quisumbing, A. (2013). Closing the Gender Gap. In *2012 Global Food Policy Report* (pp. 39–47). Washington, DC: IFPRI.

Michalscheck, M. (2014). Farm Typology for the Eastern Province, Zambia. Draft.

Miller, S. (2012). Social Institutions. In *The Stanford Encyclopedia of Philosophy*. Retrieved July 17th 2014 from <http://plato.stanford.edu/archives/fall2012/entries/social-institutions/>.

Moser, C. (1993). *Gender Planning and Development: Theory, Practice and Training* (p. 285). Routledge.

Norris, A. N., Zajicek, A., & Murphy-Erby, Y. (2010). Intersectional Perspective and Rural Poverty Research: Benefits, Challenges and Policy Implications. *Journal of Poverty*, *14*(1), 55–75. doi:10.1080/10875540903489413

O'Brien, M., & Whitmore, E. (1989). Empowering Mature Women Students in Higher Education. *McGill Journal of Education*, *24*(3), 305–320.

Office of the United Nations High Commissioner for Human Rights (OHCHR). (n.d.). Committee on the Elimination of Discrimination against Women - Convention. Retrieved July 18, 2014, from http://www2.ohchr.org/english/bodies/cedaw/convention.htm

Parker, R., Lonzano, I. A., & Messner, L. A. (1995). *Gender Relations Analysis: A Guide for trainers.* New York: Save the Children.

Pearson, R. (2004). Women, Work and Empowerment in a Global Era. *IDS Bulletin*, *35*(4), 117–120. doi:10.1111/j.1759-5436.2004.tb00164.x

Ploeg, J. D. van der, Ye, J., Wu, H., & Wang, C. (2013). Peasant-managed Agricultural Growth in China : Mechanisms of Labour-driven Intensification, *21*(1), 155–171.

Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability*, *9*(1), 5–24. doi:10.3763/ijas.2010.0583

Quisumbing, A. R. (Ed.). (2003). *Household Decisions, Gender and Development. A Synthesis of Recent Research*. Washington DC: International Food Policy Research Institute (IFPRI).

Quisumbing, A. R., & Pandolfelli, L. (2010). Promising Approaches to Address the Needs of Poor Female Farmers: Resources, Constraints, and Interventions. *World Development*, *38*(4), 581–592. doi:10.1016/j.worlddev.2009.10.006

Rode, A. (2011). Literature Review : Non-Unitary Models of the Household (Theory and Evidence). Retrieved from http://www.econ.ucsb.edu/~pjkuhn/Ec250A/StudentsPapers/RodeNonUnitaryModels.pdf

Rossing, W. A. H., Groot, J. C. J., & Oomen, G. J. M. (2013). *Reader: Analysis and design of organic farming systems BFS 30306*.

Sachs, C. E. (1983). *The invisible farmers: Women in agricultural production*. New Jersey.

Scoones, I. (1998). *Sustainable Rural Livelihoods: A. Framework for Analysis. IDS Working Paper 72*.

Seasonal Calendar. (n.d.). Retrieved from http://siteresources.worldbank.org/EXTTOPPSISOU/Resources/1424002-1185304794278/4026035-1185375653056/4028835-1185375811087/3_Seasonal_calendar.pdf-July

Siegel, P. B. (2008). *Profile of Zambia's Smallholders: Where and Who are the Potential Beneficiaries of Agricultural Commercialization? Africa Region Working Paper Series No. 113 June 2008*. Retrieved from http://www.worldbank.org/afr/wps/WPS113_Zambia_Smallholder.pdf

Simukoko, H., Marcotty, T., Phiri, I., Geysen, D., Vercruysse, J., & Van den Bossche, P. (2007). The comparative role of cattle, goats and pigs in the epidemiology of livestock trypanosomiasis on the plateau of eastern Zambia. *Veterinary Parasitology*, *147*(3-4), 231–8. doi:10.1016/j.vetpar.2007.04.005

Sraboni, E., Malapit, H. J., Quisumbing, A. R., & Ahmed, A. U. (2014). Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development*, *61*, 11–52. doi:10.1016/j.worlddev.2014.03.025

Stone, W. (2001). *Measuring social capital. Towards a theoretically informed measurement framework for researching social capital in family and community life*. Retrieved July 18th 2014 from http://www.aifs.gov.au/institute/pubs/RP24.pdf

Syed, J. (2010). Reconstructing gender empowerment. *Women's Studies International Forum*, *33*(3), 283–294. doi:10.1016/j.wsif.2010.03.002

Teklewold, H., Kassie, M., Shiferaw, B., & Köhlin, G. (2013). Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income, agrochemical use and demand for labor. *Ecological Economics*, *93*, 85–93. doi:10.1016/j.ecolecon.2013.05.002

The Montpellier Panel. (2013). *Sustainable Intensification : A New Paradigm for African Agriculture*. London.

The World Bank. (2011). *World Development Report 2012. Gender Equality and Development* (pp. 271–343). Washington DC. doi:10.1787/9789264179370-6-en

Timler, C., Michalscheck, M., Klapwijk, C., Mashingaidze, N., Ollenburger, M., Falconnier, G., Groot, J. (2014). *Africa RISING Farming Systems Analysis Phase 1 Final Report*.

UNESCO's Gender Mainstreaming Implementation Framework. Baseline definitions of key concepts and terms. (2003). Retrieved from portal.unesco.org/en/files/11483/...doc/Definitions.doc

United Nations Development Programme (UNDP). (n.d.). Human Development Index (HDI) | Human Development Reports. Retrieved July 13, 2014, from http://hdr.undp.org/en/statistics/hdi

United Nations Entity for Gender Equality and the Empowerment of Women (UN Women). (n.d.). Guiding Documents. Retrieved July 18, 2014, from http://www.unwomen.org/en/about-us/guiding-documents

United Nations Gneral Assembly. (1997). *A/52/3 General Assembly Fifty-second session REPORT OF THE ECONOMIC AND SOCIAL COUNCIL FOR 1997**. Retrieved from http://www.un.org/documents/ga/docs/52/plenary/a52-3.htm

United Nations Treaty Collection (UNTC). (n.d.). Convention on the Elimination of All Forms of Discrimination against women. Retrieved July 18, 2014, from https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-8&chapter=4&lang=en

Vaus, D. de. (2013). *Surveys In Social Research* (p. 400). Routledge.

Annex

Annex I: List of Expert Interviews

Koos Kingma	University of Applied Sciences Van Hall Larenstein May 19th 2014
Dr. Holger Kirscht	International Institute for Tropical Agriculture, Gender Focal Point to two CGIAR Research Programs May 8th 2014
Annet Abenakyo Mulema	International Livestock Research Institute, Gender Specialist May 23rd 2014
Anne Rietveld,	Bioversity International, Gender Focal Point for the CGIAR Research Programs on 'Roots, Tubers and Bananas' and 'Humid Tropics'. April 29th 2014
Dr. Amare Tegbaru	International Institute for Tropical Agrculture. Author to the Gender Strategy of the CGIAR Research Program Humid Tropics May 7th 2014
Dr. Parto Teherani-Krönner	Humboldt Universität zu Berlin, Gender and Globalization April 30th 2014
Dr. Annemarie Westendorp	University of Applied Sciences Van Hall Larenstein May 20th 2014

Annex II: Guiding Questions for Ecpert Interviews

Two Parts of the Interview

1. Your Work Experience
2. Farming Systems Analysis and possible ways to include Gender
    - Gendered Division of Labour
    - Division of Responsibilities in Household Spending
    - The relation between women's assets/ empowerment and household nutrition
    - Ownership of assets and access to Resources
    - Others?

1. Your Work Experience as Gender Focal Point within CGIAR

1.1 What is your experience with farming systems analysis?

1.2 Do you think quantitative methods are useful to assess gender relations within a household?

2. Farming Systems Analysis and possible ways to include Gender

2.1 Gendered Division of Labour

2.1.1 I have come across a presentation on empowering women in Agriculture for the Feed the Future Initiative by the US government. In this presentation three key ways of empowering women with the aim to improve household nutrition are mentioned:

-increase market access and income control
-increase decision making power
-reduce labour and time requirements (to allow save pregnancy and sufficient time for infant feeding) (Herforth, 2014)

While an increase in market access and income control as well as decision making power probably correlates with more labour, the third objective is to reduce women´s total labour.

- Do you think these three goals are conflicting each other?

2.1.2 For now in Farming Systems Analysis one generally distinguishes between regular (skilled) labour and casual labour that is mainly used during seasonal labour peaks.

How do you think, one could extend this analysis?

2.2 Division of Responsibilities in Household Spending

2.2.1 Have you heard of the discussion paper `Putting Gender on the Map" by IFPRI (the International Food Policy Research Institute)?
It looked at the division of labour and rights to access resources between women and men in various farming systems in Sub-Saharan Africa. The paper proposes the introduction of a household typology that differentiates between: male managed; female managed, jointly managed and separately managed farming systems. Mapping the dominant household structure within a region is hoped to inform agricultural scientists and extension workers about the appropriate decision maker to target (Meinzen-Dick et al. 2012).

-Do you think the differentiation between these 4 different household structures is adequate?
-Do you think one can distinguish a dominant household structure for a region?
-For those households with separate management, do you think one could assess the income sources and expenditure responsibilities for the different household members?

2.3 Women's Empowerment, Agricultural Productivity and Household Nutrition

2.3.1 It is often stated that by increasing women's participation in decision making one could improve crop yields household nutrition and improve the households financial management.

-Could it be that this is not a causal relation, but another external factor influences all these factors? For instance that households that are better off might have a better education, which also fosters more equitable decision making?

2.3.2 The Women's Empowerment in Agriculture Index, developed by IFPRI, measures women's empowerment by assessing five domains: Production, Resources, Income, Leadership and Income. It then compares women's scores in these five areas with those of men in their household to measure gender parity (see table below)

Table 1: Domains of the Women's Empowerment in Agriculture Index

Domain	Indicators	Weight
Production	Input in productive decisions	1/10
	Autonomy in production	1/10
Resources	Ownership of assets	1/15
	Purchase, sale, or transfer of assets	1/15
	Access to and decisions on credit	1/15
Income	Control over use of income	1/5
Leadership	Group member	1/10
	Speaking in public	1/10
Time	Workload	1/10
	Leisure	1/10

Source: IFPRI 2012, p.3

-Do you think this index could be useful to include in the farm model?
-What do you think could be the relation between women´s empowerment measured in this way and Agricultural productivity?
-How about the relation to household nutrition?

2.4 Ownership of Assets and Access to Resources

2.4.1 It is often quoted from the SOFA report that equal access to resources for women would allow them to raise agricultural productivity 20 to 30 per cent.
-Do you think this is realistic?
- What about time constraints that might hinder women in engaging more in agricultural work?

2.4.2 A mathematical model could theoretical calculate the productivity of women farmers assuming equal access to land, fertilizer and seeds.
-What would be the benefit of such a calculation?

2.5 Other ways to include gender in farm models.

2.5.1 We discussed gender division of labour and separate economic units within a household as most apparent ways to extend farm models. Can you think of anything else that I oversaw, but would be important to consider?

2.5.2 Do you think that FarmDESIGN is appropriate to assess the reality of farming systems?

References for Interview Questions:

Herforth, Anna (2014): Empowering Women in Agriculture: Maximizing Nutrition Gain Available from: http://www.spring-nutrition.org/sites/default/files/empowering_women_in_agriculture_herforth_3.26.14.pdf (25-4-2014)

Meinzen-Dick, R., Koppen, B. Van, Behrman, J., & Akamandisa, V. (2012). Putting Gender on the Map Methods for Mapping Gendered Farm Management Systems in Sub-Saharan Africa. IFPRI Discussion Paper 01153. International Food Policy Research Institute, Washington. Available from: http://www.ifpri.org/publication/putting-gender-map (25-4-2014)

[IFPRI] International Food Policy Research Institute (2012): Women's Empowerment in Agriculture Index Brochure. Available from: http://www.ifpri.org/publication/womens-empowerment-agriculture-index (25-4-2014)

[FAO]Food and Agriculture Organization of the United Nations. 2011. *The state of food and agriculture 2010–2011. Women in agriculture: Closing the gender gap for development.* Rome: FAO. (Available from http://www.fao.org/docrep/013/i2050e/i2050e.pdf (25-4-2014)